DOREMUS (C.A.) and WITTHAUS (R.A.)

CHEMISTRY

OF THE

COBB-BISHOP POISONING.

BY

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Prof. Chemistry and Toxicology at the Buffalo Medical College, and Lecturer Practical Chemistry and Toxicology at the Bellevue Hospital Medical College,

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READ BEFORE THE

MEDICO-LEGAL SOCIETY

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In consulting the records of Toxicology, one cannot but observe the fact that cases of criminal poisoning seem to occur in epidemics, and a question might very pertinently be raised as to whether these were epidemics of poisoning, or spasmodic awakenings to activity on the part of prosecuting officers. However that may be, instances of death or sickness from the action of poisonous substances are by no means uncommon, and very rarely is a case of such a nature submitted to the investigation of an expert without the discovery of some new point of interest, or of new evidence for the solution of mooted questions.

The cases to which we would direct your notice, apart from having excited popular attention from the anomalous nature of the attending circumstances, seem to us as of more interest in their chemical and physiological bearings upon Toxicology, and it is to these departments that we shall more particularly confine ourselves. To present the subject more clearly, we consider it advisable, however, to preface the chemical and physiological portion with a brief statement of the medical and legal histories.

MEDICAL.

On June 6th, 1878, Chas. H. Cobb, Jr., of Norwich, Connecticut, died in convulsions within a short time after his mid-day meal. He had for several months previously suffered from peculiar attacks of illness, the cause of which his medical attendants could not clearly

define ; a post-mortem examination of the body was therefore held without, however, the discovery of any lesion indicating the cause of death. These facts, considered in connection with a scandal current in the town, to the effect that criminal relations had existed for some time between Mrs. Cobb and a neighbor, aroused suspicions of foul play, and led the coroner to institute a searching inquiry. At the autopsy, precautions were taken to preserve the organs in a proper condition for chemical analysis in case that were deemed necessary, and, as the physicians were unable to detect any pathological change in the body, such an analysis was ordered by the coroner.

One of the coroner's jury was sent to New York with the viscera, which were received on June 8th, and immediately submitted to chemical investigation. As the result of this preliminary examination, at the end of a fortnight a report was made to the coroner stating that considerable quantities of absorbed arsenic had been detected. This report confirmed so completely the suspicions rife in the public mind that Wesley W. Bishop, the supposed murderer, was summoned before the jury as a witness. Bishop's wife had died in the previous February after a brief illness, and as the suggestion had been made that she had also succumbed to a dose of poison, at Bishop's request, the coroner ordered Mrs. Bishop's remains to be exhumed, after a burial of five months, and an autopsy made—the same physicians acting as in the case of Mrs. Cobb. In this instance also, the physicians failed to discover any natural cause of death, and a chemical analysis of the viscera was ordered. After another two weeks, in a second report to the coroner, absorbed arsenic was declared to be present in the body of the deceased. Circumstantial evidence had been gathered in the meantime, and the jury found a verdict of death by poison in the case of Mr. Cobb, as well as in that of Mrs. Bishop, and added that in the belief of the jury the poison was administered by Wesley W. Bishop and Kate M. Cobb, who were therefore held for trial.

MRS. HATTIE E. BISHOP.

Symptoms.—From the testimony of Bishop on the trial of Kate M. Cobb, it appears that in the latter part of October, 1877, he and the defendant had discussed the advisability of either eloping, obtaining divorces, or of murdering those who stood in the way of the satisfaction of their mutual attractions. About the first of the following February, Mrs. Cobb and Mrs. Bishop went sleighing together ; immediately after this sleigh-ride Mrs. Bishop was taken ill, as was supposed, from having taken cold. She shortly became worse, and on Wednesday, Feb. 6, a physician was called to attend her, between two and three o'clock at night. According to his prescription and instruction, powders were administered every three hours, and aconite each hour, beginning fifteen minutes after taking the first powder.

This treatment was kept up until the morning of Feb. 7, and she died that night at about midnight, having been in a comatose condition from about five A. M. until her death.

The physician in attendance failed to discover, as he stated on the trial, any satisfactory cause of death, and had not formed an opinion as to whether or not it was due to poison ; in fact, he rather inclined to the belief that the symptoms did not indicate poisoning.

Bishop, in his confession and in his testimony, says that he substituted a dose of three grains of morphine for one of the powders, that given at ten P. M., Feb. 7, but denied any knowledge of the administration of arsenic.

Post-mortem appearances.—The exhumation of Mrs. Bishop's body was ordered while one of us was in Norwich, on June 26th, 1878. The body was raised from the grave, and found in the following condition, after a burial of five months: The outer wooden box had the appearance of one recently buried, the earth surrounding was dry, the screws in the coffin were slightly rusted, the silver mountings somewhat tarnished. On opening the coffin at the undertakers, there was a strong, musty odor, without any marked odor of putrefaction. The face, neck, head and hands were covered with a peculiar mould. (These parts were the only ones not covered by clothing.) The face was discolored, but on removing the clothing the surface of the body was found in a much better state of preservation than the face and neck; the abdomen and thighs were very little changed. The dissection was made by the same physicians who had previously held the post-mortem examination of Mr. Cobb's remains. q. v.

The brain was removed and placed in a clean jar. It was sufficiently firm to distinguish the white from the grey matter, and to admit of its removal from the cranial cavity with a spoon : neither conjestion nor clot were observed.

On opening the abdomen the viscera were found in a remarkable condition of preservation. *The intestines* were slightly inflated with gas ; were normal in color and had undergone but little change. Subsequently on opening them in New York, a slight inflammation was noted, especially near the pylorus and in the rectum. The contents were semi-fluid and measured 77cc. (2½ fl. oz.) Some parts were of an orange color, others towards the rectum, greenish. The contents were alkaline, the taste not bitter.

The stomach, though empty, was ligated at both extremities. On subsequent examination the mucous membrane at the cardiac extremity was found much inflamed ; there were no contents, but white specks of a hard substance were found covering the inside at points. Some of these came off readily, while others were imbedded.* The

* Tardieu sur l'Empoisonnement 1875, p. 365, speaks of having tested white and yellow specks observed in the stomach in cases of poisoning, but found them to be formed "exclusively of albumin and fatty matter." Triple phosphate crystals are frequently present after long interment.

pylorus was scarcely inflamed; the appearance of the œsophagus was like that of the cardiac end of the stomach. *The liver* was removed along with the gall bladder. The latter contained a small stone, and a little bile The liver showed no signs of disease. *The heart, spleen* and *kidneys* were also examined and removed for analysis, as also a piece of the psoas *muscle*. None of these parts were abnormal in appearance. *The uterus* and *bladder* were examined. Both were found empty and neither inflamed. The physicians, after this careful inquiry, having examined the various organs and failing to observe any appearance which would indicate a natural cause of death, recommended that a chemical analysis be made; in accordance with which, the portions of the body desired were placed in new and scrupulously cleaned glass jars, which were sealed and taken to New York.

CHAS. H. COBB, JR.

Symptoms.—From the testimony of the attending physician, and of Mr. Cobb, Senior, it seems that prior to the 27th or 28th of February, 1878, the deceased had been in the enjoyment of excellent health On that date, having returned late to supper, he partook of tea which had been long steeping in a Britannia teapot, and, to use his own words, "as soon as I had swallowed it, it got in my throat, and went all over me, and I was stricken numb. I felt it to the ends of my fingers." With a view to relieving his stomach, he took ipecac, and also chewed tobacco, swallowing the juice, but without producing emesis. He then, although the night was stormy, walked about a mile to the residence of Dr. W. S. C. Perkins. The doctor prescribed an emetic. Soon after leaving, and while on his way home, the ipecac and tobacco produced their effect on Cobb, and the prescription was therefore not taken. The doctor attended him again professionally in the latter part of April. In the meantime Cobb had, upon one or two occasions, suffered from nausea, vomiting, and numbness of the extremities, from which latter symptom he never entirely recovered. On the occasion of his second visit to the doctor, he complained of numbness and frequent attacks of vomiting and purging. Between this and the next time that the doctor saw him, which was in the last of May, Mrs. Cobb called upon him several times with regard to her husband. Dr. Perkins was rather inclined to the belief that Mr. Cobb was suffering from lead poisoning, and prescribed potassium iodide and quinine. No source of plumbism was discovered, however. In May the doctor saw him again, and he complained of the same symptoms. The skin at that time was dry and scaly, and the face quite smooth, the beard having fallen out. The doctor saw him last in the latter part of May. On the day of his death (June 6th), Dr. Perkins was called, but arrived only to find the patient dead. During an illness

of Dr. Perkins, Mr. Cobb was attended by Dr. L. S. Paddock, who was called on the 3d of June. He also attributed the symptoms to lead poisoning, and administered the following prescription :

R. Strychnia sulph. - - - gr. i.
Ac Phosphoric dil. - - ℥i.
Syr Simp. - - - - ℥iii.
M. Sig. Dose, 1 teaspoonful in water before meals.

This Cobb partook of, the last dose just previous to the meal after which he so suddenly succumbed. Upon his visit to Dr. Paddock, Mr. Cobb spoke of a sense of constriction and burning in the throat, great weakness and muscular depression, pain in the abdomen, legs, thighs and arms, a sense of numbness, lack of muscular power, unsteadiness of gait, loss of sensation. The wrist also had a tendency to drop, but there was neither the blue line on the gums characteristic of lead poisoning, nor was lead found in the urine. The legs, from the knees down, were effected with a scaly eruption. On the 6th of June, about half-past twelve, the elder Cobb was summoned to his son's residence. Upon reaching it, he found him lying upon the lounge, and, as Mr. Cobb testified : "I went to the lounge ; I kneeled down and said, 'Charlie, do you know who is here?' He said, 'I do." I think those were the last words he ever said. He went into spasms. * * * Soon the spasms were succeeded by relaxations, and he died in a moment. He died not far from one o'clock."

According to the confessions and testimony of Bishop, Mrs Cobb administered several doses of morphine, purchased by Bishop, to her husband in the first part of February, 1878, and previous to Mrs. Bishop's illness. Cobb complained of the bitter taste of his food at the time. Shortly after this strychnine was bought by Bishop,* and, as he claimed, administered by Mrs. Cobb to her husband in some bitters that he was using. A few days after Mrs. Bishop's death, Mrs. Cobb, in conversation with Bishop, complained of her ill luck, stating that she had tried morphine two or three times, and failed. She then suggested aconite, which, according to Bishop, she gave towards the latter part of February. This presumably caused the sickness after partaking of the tea. Towards the first of March Bishop obtained some arsenic for Mrs. Cobb, which she administered repeatedly from that time till her husband's death, giving it to him nearly every day, sometimes twice a day. At about the period of Mr. Cobb's second illness, in March, when Dr. Paddock prescribed strychnine, Bishop claimed that he purchased some of that substance, a portion of which he used to kill rats, while Mrs. Cobb used the rest to kill her husband. This strychnine was to be added to the medicine.

* Bishop formerly kept a drug store, knew of the properties of these poisons, and could purchase them without attracting attention.

Post-mortem appearances.—The examination was held on the 7th of June, twenty-four hours after death, by Drs. W. S. C. Perkins, L. S. Paddock, C. M. Carleton and E. C. Kinney. In a letter from Dr. Perkins we have a concise account of the appearances. This account agrees with the separate statements of the physicians at the trial.

"Rigor mortis well marked; body fairly nourished; skin dry and scaly; hypostatic congestion of all the depending parts; marked congestion of the scrotum, mottled with red, white and purple. Pupils dilated; jaws firmly closed; tongue not between the teeth. Bloody discharge from anus. Very slight indications of beard. No fluid in peritoneal sac. Muscles of abdomen normal in appearance. Stomach somewhat distended with gas, also intestines; spleen normal; liver apparentl healthy; gall bladder empty. Left kidney, length, 5 in.; width, 3 in. In superior portion a degeneration about 1½ in. in depth, 1 in. in width, extending through the kidney, just breaking down into pus. Capsule healthy. Right kidney somewhat congested, but otherwise healthy. About 3½ oz. fluid blood in right side of heart. Valves healthy. Lungs gorged with blood, but healthy. The brain was closely examined. No coagula or serum found. The upper portion of spinal cord was also examined, but nothing abnormal found."

Referring to the notes taken at the time of the examination of the viscera of Mr. Cobb, made in New York, we find the following: There were in one large glass jar the stomach, ligated at both extremities, the intestines (all but the lower portion) also ligated, both kidneys, the liver, spleen, heart and some bloody fluid.

The stomach contained a mass of semi-fluid substance of a light grey color, not very unpleasant odor and of an acid taste. The contents measured 210cc. (7 fl. oz.) The contents were acid in reaction, and no suspicious particles were observed in the mass. The tissue was pale in color, not conjested, not perforated or inflamed. Stomach slightly green at cardiac extremity, and was found inflated by gas. No foreign substance adherent to lining membrane.

The intestines were much distended with gas. No inflammation or perforation. Opened July 20th. Contents 375cc. (12½ fl. oz.) green in color—some portions orange. Reaction alkaline, slightly bitter taste, though not persistent. The odor at that late day was putrescent. The tissue was not unusual in appearance, except that parts were yellow in color.

The other organs presented the condition already described.

On Wednesday, June 26th, 1878, after making an autopsy of the remains of Mrs. Bishop, those of Mr. Cobb were examined, they having been exhumed for that purpose. The condition of the body was compared with that of Mrs. Bishop, and the decay found to be advancing more rapidly.

The brain had been placed in the abdomen after its examination at the first autopsy. Such parts as could be removed with a certainty that they had not been contaminated by resting upon the walls of the abdomen, were placed in a clean jar and taken to New York.

The urine was removed from the bladder by a catheter, and placed in a new and clean bottle. The bladder was then opened and found devoid of inflammation, though the urine on subsequent examination proved to contain blood coloring matter.

The *muscles* of the right thigh were dissected, part being taken for analysis.

The *rectum*, and a portion of the *lower intestines* remaining, showed slight signs of inflammation.

LEGAL.

The judicial proceedings were as follows: After the coroner's jury had rendered their verdict, Mrs. Kate M. Cobb and Wesley W. Bishop were imprisoned to await trial before the City Court. This was held at Norwich on July 15th, 1878, before Judge Kellogg, and resulted in the remanding of the prisoners to await the action of the Grand Jury. At a session of that body, held at New London September 11th, 1878, Kate M. Cobb was indicted for the murder of her husband, and Wesley W. Bishop for that of his wife, and as an accomplice in the murder of Chas H. Cobb, Jr. Wesley W. Bishop was to have been tried first, but owing to his confession, it was deemed expedient to prosecute Kate M. Cobb first, using Bishop as a witness.

Her trial, after some delay, began on December 31st, 1878, in the Superior Court at Norwich, Judge Culver presiding, and Chief Justice Park acting as associate, and lasted nearly three weeks.

The Hon. Thos. M. Waller, State's Attorney, and Col. Geo. P. Ripley, City Attorney, for the State, and the Hon. John T. Wait and Messrs. Thresher and Gardiner Greene, Jr., for the prisoner.

Mrs. Cobb was found guilty of murder in the second degree, and sentenced to imprisonment for life.

On May 20th, 1879, Wesley W. Bishop was brought before the same tribunal and pleaded guilty to murder in the second degree. The plea being accepted by the Court, Bishop was sentenced to hard labor for life.

CHEMICAL.

Having thus briefly sketched the medico-legal history of the case, before proceeding with an examination of those questions of toxicological interest which have presented themselves during its course,

we would pause for a moment to say a few words concerning the duties of those having charge of the earlier phases of such inquiries. Although authors have repeatedly drawn attention to the precautions required, and to the fact that their observance or neglect materially aids or hampers the chemical expert, it yet too often happens that even coroners and their deputies are incapable of answering the two vital questions: What parts shall be preserved for analysis, and how shall they be preserved and conveyed to the expert? We feel the more at liberty to refer to these points in this connection, as in this case exceptional care was taken by those having the autopsies in charge.

Whenever practicable, the chemist should be present at the autopsy, not only that he may then, by observing odors peculiar to certain volatile poisons, obtain indications of great value, but that he may then and there take possession of the organs, and thus be qualified to testify that the viscera which he examines are those of the deceased. The stomach and intestines should never be opened at the autopsy, but should be transmitted to the chemist, with their contents enclosed by ligatures. A failure to conform to this rule is attended with no gain, but with probable loss to justice. The *toxicological* chemist is as capable of determining as the physician whether or not the stomach or intestines are in an abnormal condition; while, on the other hand, indications valuable to the chemist, but of little significance to the physician, are lost if the interior of the alimentary tract have been allowed to come in contact with other organs, or its contents mixed with other substances. The detection of small particles of foreign matter not only indicate to the chemist the probable nature of the poison, but may frequently become as important a link in the chain of circumstances connected with the murder as is the weapon with which the blow is dealt in a homicide by violence. To detect and determine the nature of such particles, a practiced eye and conveniences found only in the laboratory are necessary.

Nor is it sufficient for the chemist to examine the stomach and intestines, for, on the one hand, the poison there found is no proof that the victim had succumbed to its action, unless it be found in other parts of the body as well; on the other hand, an individual may have been poisoned without any trace of the poison remaining in the stomach, it having been entirely removed from that organ by absorption into the blood, by vomiting, or indirectly by purging. In order, therefore, that the chemist may perform his duty properly, he must receive for examination not only the intestinal tract, but deeper seated organs as well—the liver, spleen, kidneys, muscular tissue, any urine that may remain in the bladder, and the brain.

It would seem trivial to state that during their transit from the

post mortem room to the laboratory, the jars containing the organs should be so protected by seals as to render any tampering with their contents a physical impossibility, were it not for the fact that this precaution is sometimes neglected. The suggestion that each organ be placed in a separate vessel is one which should be followed, as important corroborative evidence often results from a comparison of the quantities of poison found in the different organs.

The preliminary examination made in the Cobb case was confined to a search for poisons in the contents of the stomach and one-third of the tissue of the liver and half of one kidney. In this examination the absence of such poisons as phosphorus, hydrocyanic acid and other volatile bodies, was settled. The detection of arsenic gave bases upon which to report to the coroner's jury. This preliminary testing was conducted by Prof. Doremus alone. All other steps in the analysis were taken only after consultation and with the approbation of both of us.

In the conduction of the examination of the viscera of Mr. Cobb and of Mrs. Bishop, a method of analysis was followed which would permit of the detection of any of the more usual poisons in one and the same viscus; indeed we are strongly of the opinion that the analyst is never warranted in submitting the parts to the action of any reagent which would preclude the subsequent detection of a well known toxic agent, until he has fully satisfied himself of its absence. In the cases under consideration, there was at the outset of the investigation no suspicion of the use of any poison other than arsenic, yet, according to the subsequent confession of one of the accused, arsenic, strychnine, morphine and aconite had all been administered to the deceased at various times. It will be readily understood that in a case such as this, and in fact in any case, the detection of a second poison may become a very important factor in the evidence, and the chemical expert who considers his work at an end with the detection of a single poison, is in danger of occupying a very unenviable position upon the trial. Some systematic method of procedure is therefore essential, notwithstanding the contrary opinion, implied if not expressed, by a writer upon toxicology whose work is frequently quoted in our law courts, who not only fails to give any methodical process, but actually condemns one of the best we have on the ground that it is too "minute and elaborate." (1)

(1.) Taylor on Poisons, 3d Amer. Ed., p. 326, in speaking of Frezenius and v. Babo's method says: "It provides for the exclusion of lead, bismuth, mercury, copper, tin, antimony and other metals; but in thus excluding many bodies which are never likely to be found * * * * *" We must differ with Dr. Taylor as to the uselessness of excluding these substances: lead, mercury and antimony may assuredly be present in cases of poisoning: tin may exist as an impurity in distilled water and in alcohol: copper is almost always found in the liver and other tissues, and bismuth may have been administered as a medicine when, as in the case of Cobb,

The method which we have followed consists of a combination of the Stas process as modified by Otto, (1) and the process of Frezenius and v. Babo (2) with certain slight but not unimportant alterations. The detection of phosphorus and of the volatile poisons is not included in this method, as this forms a portion of the preliminary examination when it may be effected at the earliest possible moment after death, and in such a manner as not to interfere in any way with the subsequent operations. The preliminary testing in these cases demonstrated the absence of these substances.

Leaving out of consideration phosphorus, ether, &c., the poisons may be arranged in the two great classes of mineral and organic, and the first step in an analysis is the separation of these from each other, as the methods for their detection do not only differ materially, but in many instances interfere with each other. To effect this separation two methods have been recommended, neither of which seems to us to be satisfactory. Tardieu (3) recommends that the organs be divided into two equal parts, one of which is to be used in searching for mineral poisons, while the other serves for the detection of those of an organic nature. By this method the chances of detecting and estimating any poison present, are diminished one-half, a risk which we might be justified in taking could we be certain in advance that the case in hand was one of those exceptional instances in which there remained a large quantity of unabsorbed mineral poison in the alimentary tract, but which would operate powerfully against the detection of an absorbed vegetable poison. When the toxic agent is an alkaloid, the quantity found in the tissues is always small, and we should therefore operate upon the greatest possible amount of material if we would have clear and convincing results.

Another method is that by dialysis, first suggested by Graham in 1862. (4) Unfortunately this process, which is less laborious than any other, is deficient in two very important particulars: it is not capable of separating all the poison present, and, unless a large quantity of water be used, the loss is very considerable; moreover, that portion which is obtained is contaminated with various other substances; the method thus failing to accomplish satisfactorily the principal end in view.

From the satisfactory results obtained in this and other cases, we are led to recommend that the methodical analysis should begin with

the question as to whether arsenic detected in the body found its way there as an impurity of the medicine, or as a poison, becomes a delicate and a very important problem. The Reinsch test for arsenic, of which Dr. Taylor thinks so highly (p. 315), is of no value whatever unless it be so conducted as to exclude four of the six metals named.

(1.) Otto. Ausmittelung der Gifte., 5th Ed., pp. 65 et. seq.
(2.) Ann. d. Chem. u. Pharm., XLIX., pp. 287–313.
(3.) Etude Médico-Légale sur l'Empoisonnement, p. 75.
(4.) Journ. Chem. Soc., XV. 264.

the first step of the Stas Otto process, *i. e.*, maceration of the finely-divided organs in alcohol acidulated with acetic or tartaric acid. When the organs are first obtained for analysis those portions which are to serve for a preliminary examination should be removed, and the entire remaining parts placed with acidulated alcohol in closed vessels, which are set aside. [1] While the preliminary examination (which usually occupies two or three weeks) is in progress the alcoholic fluid is removed and renewed two or three times: that portion of the organs not dissolved by the alcohol will now contain any insoluble metallic poison, while the filtered alcoholic fluids, by spontaneous evaporation, yield a residue in which any poisonous alkaloid which might have been present in the organs will be found as an acetate or a tartrate. The advantages of this method of procedure are numerous: the greatest possible quantity of each organ is used, and therefore the chances of detecting and estimating a small quantity of poison are the best attainable. The vegetable poisons are protected from the influences of putrefactive changes at the earliest moment, and by the long-continued and repeated maceration the extraction of the alkaloids is thoroughly effected. It may be objected that the separation of mineral from organic poisons is not complete, as any metallic substance soluble in alcohol will pass with the alkaloids into the alcoholic fluid. This fact, far from being an objection, is of great advantage, as it does not interfere with the detection of the alkaloids, which, in the later steps of the Stas process, are further separated and purified, while the metallic substances remain in the residues which may be subsequently treated for their discovery. On the other hand, this separation of soluble from insoluble mineral matter is frequently of great advantage, and from a comparison of the amount found in these residues with that found in the tissues, important indications may be had of the form in which the poison was taken.

Mineral poisons.—The chief difficulty in the detection of mineral poisons in the fluids and tissues of the body is the complex nature of the substances with which they are mixed. As is well known, the presence of organic matter interferes with the action of the various tests, and often renders their indications deceptive. Orfila is reported to have said: "Si j'avais à faire en une ligne une leçon de toxicologie, je dirais aux experts ces seules mots. Méfiez vous de la matiere organique." [2]. Bence Jones [3], in a paper upon the detection of sugar in the urine, says: "Nothing is easier than to determine the presence of small quantities of sugar, arsenic or opium in distilled water, but when organic matters are also present the difficulty of the analysis becomes sometimes excessive. Very small quantities cannot be detected. * * * In cases of poisoning,

(1.) The stomach, intestines, liver, brain and urine should be treated separately.

(2.) Tardieu, l. c., p. 92.

(3.) Quart. Jour. Chem. Soc. XIV. (1862), p. 22.

the separation of the poison from the contents of the stomach, or from the substance of the different organs of the body, constitutes the whole difficulty." Harley [1], in speaking of the presence of iron in normal urine, and of the *failure* of Sherer and Hassall to detect it, says: "Dr. Hassall's inability to detect it (iron) arises no doubt, from his testing the urine directly, instead of first evaporating and incinerating the residue before applying the tests for the metal. Iron, like most other metallic substances, being quite undetectable when mixed with organic matter, unless present in enormous quantity." Bouis [2] writes: "Dans les recherches chimico légales les matières toxiques sont ordinairement mélangées aux matières animales ou végétales qui masquent leurs caractères et s'opposent à leur reconnaissance. Il est nécessaire dans ce cas de détruire la matière organique:" and again: "La plupart des matières organiques masquent les réactions ordinaires des sels métalliques et peuvent égarer les experts sur la véritable nature des substances soumises à leur examen. * * * On a bientôt senti la nécessité de se mettre à l'abri de ces causes d'erreur, et pour la recherche des substances minerales on a proposé de se débarrasser avant tout des matières organiques." Mohr [3] says: "Es ist bekannt dass viele organische Stoffe chemische Fällungen ganz verhindern oder die Erscheinungen doch wesentlich verändern." We give these extracts, showing the unanimity with which toxicological chemists agree upon the necessity of disposing of organic matter before applying special tests, in view of the fact that in a recent trial a prominent chemist in a neighboring State advanced the contrary opinion, that no such destruction is necessary. We need scarcely remark that upon this point we see no reason to differ from the authorities quoted.

The various organs, after having been finely divided and after the extraction with alcohol already mentioned, were treated with hydrochloric acid, water and potassium chlorate at the temperature of the water bath in the manner recommended by Frezenius and v. Babo [4]. Modern toxicological chemists, almost without exception, with good reason consider this as the best method yet devised; Wormley [5], Otto [6], Bouis [7], Sonnenschein [8], Dragendorff [9], and Bloxam [10], recommend its use; on the other hand some modern authors object to it: Woodman and Tidy [11] "are convinced (it) is neither

(1.) The Urine and its Derangements, p. 342.
(2.) Briand, Chaudé et Bouis Manuel de Médecine-Légale 9, eme. ed., pp. 660, 661.
(3.) Mohr Chemische Toxicologie, p. 17.
(4.) Ann. d. Chem. u. Pharm., XLIX. pp. 287-313.
(5.) Micro-chemistry of Poisons, pp. 300–305.
(6.) Ausmittelung der Gifte, 5th ed., I p. 18, 20, 100 and recte.
(7.) L. C., p. 663.
(8.) Handbuch d. Gerichtlichen Chemie, p. 305.
(9.) Ger. Chem. Ermitt d. Gifte, 2d ed., pp. 308. et seq.
(10.) J. Chem. Soc., XIII, 19.
(11.) Fore nsic Medicine, p. 33.

a desirable nor advisable one for use in practical investigations." In another part of their work [2] they state their objections to be "that both the reagents used (chlorate of potash and hydrochloric acid) may contain the poison, and that the chlorine and chloric oxide evolved, carry away with them a large portion of the arsenic in the form of a volatile chloride." In answer to the first objection we would say, that although potassium chlorate may in exceptional cases contain arsenic, it is by no means as liable to be so contaminated as is hydrochloric acid, and may easily be obtained in a state of absolute purity; with regard to the acid it cannot be more difficult for the chemist who uses hydrochloric acid in this process to satisfy himself of its purity, than it is for our authors to do so when they use it in the process which they recommend [3]. As to the second objection, while we would admit the possibility of the formation of the volatile chloride when arsenic trioxide is heated with hydrochloric acid *alone*, as recommended by Woodman and Tidy, we fail to comprehend how such an action can be increased, or can take place at all, when by the addition of the chlorate the trioxide is *oxidized* to arsenic acid [3].

Tardieu [4] prefers the process of carbonization by sulphuric acid, a process in which there is loss of arsenic (if that element be present) by the formation of the volatile arsenic trichloride in the presence of the never absent chlorides. Taylor [5], as we have seen, contents himself with condemning the method in his dogmatic way, because it is to his mind an "exhaustive" process. Finally, Mohr [6] prefers to heat the substances with hydrochloric acid alone for some time, without the addition of potassium chlorate, losing sight, as it would seem, of the fact that by this treatment, if arsenic be present as arsenic trioxide (as is very likely to be the case), there will certainly be loss from the formation and volatilization of the trichloride, while, by the addition of potassium chlorate at the outset, this is rendered impossible through the oxidation of any white arsenic present to arsenic acid, which is not volatile and which has no corresponding chloride; his exceptions to the use of chlorate are, with one exception, not well taken, and his one valid objection, *i.e.*, that after the contents of the stomach have been treated with acid and chlorate it is no longer possible to determine whether the poison was present in a soluble and, therefore, active, or in an insoluble and for the time being innocuous form, cannot

(1) L. C., p. 154.
(2) L. C., p. 153.
(3.) In this connection, see also Otto, l. c. p. 98. Frezenius Ann. d. Chem. u. Pharm., 49-296. Zeitsch. f. Anal. Chem., 1-448.
(4.) L. C., pp. 94.353.
(5.) L. C., p. 326.
(6.) Chemische Toxicologie, pp. 47-48

be maintained if the separation of soluble from insoluble mineral matter have been effected at the outset as we have suggested.

The treatment with chlorate and acid was continued with the various parts until the mass became fluid and of a light yellow color, holding in suspension a small quantity of granular matter and oil globules in varying quantity (1). The time and the quantities of reagents required to bring about this result varied materially with the different parts; the intestines yielded a clear fluid in less than an hour, and with a small quantity of chemicals while, on the other hand, the brains of both the deceased, although the body of Mrs. Bishop had been buried five months, required large quantities of reagents and a treatment of nearly twenty hours before the disintegration was considered satisfactory although not complete, there remaining a small quantity of fibrous material resembling a tangled mass of short curls. See p. 27). The yellow fluids were allowed to cool (2) slowly until the odor of chlorine had disappeared (in those instances where large quantities of acid had been used the fluid was treated with carbon dioxide before cooling), after which they were filtered and the clear fluids so obtained treated with washed hydrogen sulphide. The gas was allowed to pass several hours, the fluids being occasionally warmed, after which the flasks were corked and allowed to stand from 24 to 48 hours, at the end of which time the treatment was repeated and the precipitate which formed in each instance was collected upon a filter. From these and other cases we are convinced that the long continued passage of hydrogen sulphide is entirely useless; in cases where arsenic is present the fluids should be treated with the gas until the odor persists after shaking, and then allowed to stand in closed vessels with an excess of the gas for a longer period than is usually allowed; time being requisite for a complete precipitation of the arsenic rather than a great excess of gas. After the precipitate so obtained has been separated, the fluid should be concentrated by evaporation, as recommended by Frezenius and by Otto, when a further deposit will be obtained which should be added to the first. The precipitates obtained were all of a dirty yellow or brown color, those from the spleen and the liver being the darkest: they were collected upon small filters and submitted to the next step, which consisted in washing until every trace of chlorine was removed. This portion of the process, which must be thoroughly performed, is the most tedious; in some cases we found that after a washing of twelve hours or more, the filtrates yet contained chlorine, and even when they ceased to react with silver nitrate the precipitate seemed still to contain chlorine, for by allowing them to soak over night

(1.) Fat is not decomposed by this process, but as the mineral matter is extracted from it, and as after cooling the fat may be separated by filtration, this is no objection to the method.

(2.) The absence of lead had been demonstrated

carefully covered), and testing the filtrate in the morning, the chlorine reaction was obtained. The chlorides adhere so tenaciously to the organic matter precipitated along with the sulphides, that we believe that it is better to collect these impure precipitates upon a filter and submit filter and precipitate to a second treatment with hydrochloric acid and chlorate, and the solution to a second precipitation by hydrogen sulphide, before attempting to remove the chlorine. This last precipitate of sulphides, owing to the more complete removal of organic matter, is formed much more rapidly and is more granular, and consequently more easily washed than the first; indeed the whole treatment, including the subsequent washing out of chlorine, may often be accomplished in less time than is consumed in a fruitless attempt to wash the first pasty deposit. We do not believe that this treatment is attended by any loss of metallic substances, nor can it be objected to on the ground that it increases the quantity of chemicals used, as the amount of reagents required to effect the desired end is quite small, 10-20 cc. of acid and a few pinches of chlorate usually sufficing; care should be had, however, that the sulphide be not allowed to dry, and that the temperature be not too high, lest the sulphur accumulate in hard balls which are acted on with difficulty. The precipitate obtained by this second treatment now contains all the metals of the 5th and 6th groups which might have been present, still contaminated, however, with sulphur and with organic sulpho-compounds. To separate and purify these sulphides the deposit on the filter was treated while still moist with dilute ammonium sulphydrate; in all cases this reagent dissolved the greater part of the precipitate, forming a brown solution, which, when evaporated with the wash water, yielded a residue which we will designate as *Residue A.*; in most cases there remained upon the filter an insoluble portion which we will call *Residue B.*

Residue A.—This was in every instance dark brown in color. In it would be found antimony, arsenic, tin, and copper (see p. 21), were these metals present in the substances examined (1). After partial oxidation by fuming nitric acid, these residues were fused with a mixture of sodium carbonate and sodium nitrate. After cooling, the mass was dissolved in water and the solution filtered. In every case there remained upon the filter a dark, pulverulent residue, insoluble in water, which may be designated as *Residue C.* With the exception of this black deposit, the solution was perfectly clear, and contained no white deposit, which, proved the absence of antimony and tin, carbon dioxide having previously been passed

(1.) Claus Ann. d. Chim. u. Pharm. 129, p. 209, finds that mercuric sulphide is also dissolved in small quantity by ammonium sulphydrate, and that this sulphide when subjected to Frezenius and v. Babo's test for arsenic, yields a black ring similar to that obtained with arsenic

through the solution. The solutions were evaporated to dryness and the residues so obtained decomposed by sulphuric acid, aided by heat, until all nitric acid was expelled. After cooling, the remaining pasty mass was dissolved in water, with which it formed a clear solution, and wherein any arsenic present would exist as sodium arseniate. This solution was now treated with sulphur dioxide to reduce the arseniate to an arsenite, and, after expulsion of the excess of sulphur dioxide by boiling, was treated with hydrogen sulphide and allowed to stand 24 to 48 hours. In every instance there appeared a yellow precipitate, which, upon subsequent examination, proved to be arsenic trisulphide.

Special Tests for Arsenic.

Reinsch's Test.—Concerning the value of this test, we cannot agree with Woodman and Tidy (1), or with Taylor (2), who seem to consider it superior to Marsh's test, but rather with Otto and with Mohr, who show their appreciation of its merits by their failure to make any mention of it whatever. The only advantage which it possesses over other more delicate methods—the facility with which it may be applied—is one which, however great a recommendation it may be to a medical practitioner, should have no weight with the chemical expert, when the numerous disadvantages attending its use are considered. It is by no means as delicate as the Marsh process as now applied. It fails to act in the presence of oxidizing agents, and when the arsenic present is in its higher state of oxidation. When, as in the case of Cobb, bismuth is also present, it is almost certain to escape detection if this process be employed; and, most serious of all objections, by the use of this test copper is introduced into the substances under examination, which renders the distinction between white arsenic and Paris green impossible. Although the Reinsch process is not one upon which the chemist would rely, it is still capable of affording valuable information to the physician (provided he carry it to the end, and do not consider it as complete until the characteristic crystals are obtained), who may readily apply it to the excreta of patients in cases of suspected poisoning. The practitioner should, however, not lose sight of the fact that by making use of this test in cases of criminal poisoning after the death of the victim, he is needlessly complicating the work of the analyst, and possibly making the aperture through which the criminal will escape. Notwithstanding our lack of faith in this test, we considered it advisable to use it upon a portion of the sulphides, after the presence of arsenic had been demonstrated by other tests, lest our failure to apply it should afford the counsel for the defense an opportunity for criticism. In both cases the sulphides obtained from

(1.) Forensic Medicine, p. 151.
(2.) L. c. 313 et seq., 325 et seq.

the tissue of the stomach and intestines was used for this purpose. It was oxidized with fuming nitric acid and by fusion with sodium nitrate and carbonate, the residue decomposed with sulphuric acid to expel nitric acid and then dissolved in water. The solution so obtained was treated with sulphur dioxide, boiled, acidulated with one-sixth its bulk of hydrochloric acid, and finally boiled for some time with strips of pure electrotype copper. In each instance the copper became covered with bluish metallic film. Upon drying and heating these strips in a glass tube, faint white sublimates appeared, which did not satisfactorily exhibit the crystalline appearance of arsenic trioxide. It was only with difficulty that a few small crystals could be detected in the case of Cobb, while in the Bishop case no crystalline structure could be made out (1).

Fresenius and v. Babo's Test.—This test, which was first suggested in in 1844, (2) is based upon the separation of elementary arsenic as a mirror, when its sulphide, mixed with potassium cyanide and sodium carbonate, is heated in an atmosphere of carbon dioxide; and although not as delicate as the Marsh test, is more so than that of Reinsch; its principal advantage is that antimony gives no metallic deposit, while arsenic does, thus obviating any possibility of mistaking the two; an advantage which ceases to be such when the sulphides have previously been fused with sodium nitrate and carbonate, and extracted with water, by which treatment any antimony present is separated as the insoluble antimonate of antimony; another advantage of this fusion is the avoidance of a defect in the original process pointed out by Mohr and by Rose: the arsenic being here introduced as an arseniate, the reduction is more complete than when acted upon in the form of the sulphide. In this investigation this test was used in one instance, with the sulphide obtained from the contents of the stomach and intestines of Cobb, a very well marked mirror of arsenic was obtained. During the oxidation of the first sulphide, a portion of the material was left adherent to the porcelain dish; this was subsequently dissolved off, and with a dilute solution of silver nitrate, gave the characteristic brick color of silver arseniate.

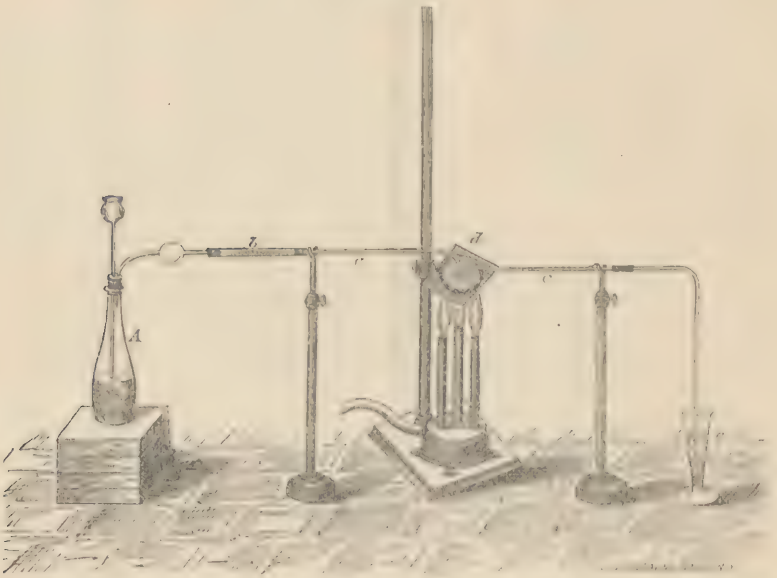
Marsh's Test.—Although still known by the above name, this test has been so modified at various times and by different chemists, that but little remains of the original process beyond the principal reactions upon which it is based, i. e., the formation of a volatile compound of hydrogen and arsenic when a reducible compound of arsenic is in the presence of nascent hydrogen, and the subsequent decomposition of this compound by heat with the separation of elementary arsenic. The form of apparatus which was used in

(1.) See Zeits. d. Ann. Chem. I. 219.

(2.) Ann. Chem. u. Pharm., XLIX. 308. See also Frez. Qual. Anal. Am. ed. of 1878, pp. [illegible]

these investigations is part of a modification of and addition to the usual Marsh-Berzelius arrangement which was suggested by Prof. R. O. Doremus, (1) and which is shown in the figure.

FIG. 1.



A is an Erlenmeyer flask of 75 c.c. capacity, about one-third filled with finely granulated zinc, and fitted with a cork through which pass a small funnel tube whose lower end is drawn out and turned up to prevent escape of gas, and a right angle tube, the end of whose vertical limb is ground to an acute angle, and whose horizontal limb has a bulb blown upon it. This is connected with a tube of greater calibre, *b*, containing fragments of calcium chloride enclosed between plugs of cotton; this drying tube is connected with a piece of Bohemian tubing *c*, *c*, about two feet in length, whose middle third is made into a coil at *d*, to afford a greater heated surface for the decomposition of the arseniuretted hydrogen; at its other extremity this tube communicates with a right angled tube dipping into a solution of silver nitrate contained in the test tube *e*. For each testing an apparatus, new in all its parts, was arranged, the zinc in it was covered with a dilute solution of platinic chloride, which was removed, and the coated zinc thoroughly washed after half an hour's contact; the apparatus was then connected, and all joints made air-tight; diluted sulphuric acid (equal parts of water and acid, cooled) was then added through the funnel tube, and the evolution of gas so produced allowed to continue for half an hour,

(1) Used in the Stephen's case in 1878. See Elwell's Malpractice and Med. Evid., pp. 514, 515. The addition mentioned in the text consisted of the subsequent oxidation of the mirror by oxygen passed in the reverse direction.

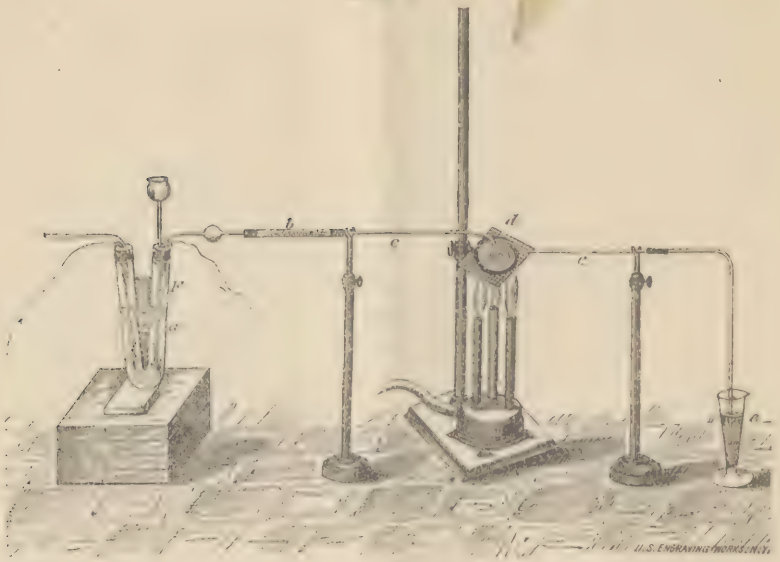
after which the coil was heated to redness, the gas was now allowed to pass through the heated coil for an hour or more, and if after this time no deposit occurred in the cold part of the tube, the suspected solution was gradually added. The entire testing usually occupied from three to four hours.

This test was applied to the Cobb case to the liver, spleen, kidneys and urine. And in the Bishop case to a portion of the tissue of the stomach and intestines, the liver, heart, spleen, kidney, and a piece of muscular tissue: in each case with the formation of a mirror of arsenic in the cold part of the tube. In almost every instance these mirrors were double, a hair brown deposit nearest the heated portion of the tube, and a more abundant steel gray deposit beyond, both of which were subsequently proved to be arsenic by their almost instantaneous solution in Labarraque's liquid. In one or two instances also there was found a faint brown deposit near the heated portion of the tube, but between it and the generating flask, possibly produced by some eddy like current at this part of the tube. As the absence of antimony had already been demonstrated, these mirrors were subjected to further examination in two instances only. The stain obtained from the heart, spleen, kidney and muscle of Mrs. Bishop was entirely and immediately dissolved by solution of sodium hypochlorite. The mirror, from one half the liver, the spleen and one kidney of Cobb, was quite large; after it had formed the generating flask was removed, and in its place was arranged a small gasometer from which a slow current of oxygen was passed through the tube; the mirror was now cautiously heated with a small flame, until one-half of it had disappeared, while adjoining the remaining half, there had formed a brilliant ring of large and well formed octahedral crystals of arsenic trioxide.

In order to meet any possible suspicion that the arsenical rings obtained had originated in the zinc and sulphuric acid used (see p. 27), in two cases the Marsh apparatus was so modified that the hydrogen was obtained from the decomposition of water by an arrangement differing somewhat from that of Bloxam and shown in the figure.

F. is a V shaped tube having a capacity of 50 cc., and is about half filled with water acidulated with sulphuric acid, in each of the openings is a rubber stopper, that in the limb *a* gives passage to a strip of platinum foil connected with the carbon pole of a battery of two large Bunsen cells, and to a right angle tube through which the oxygen liberated passes to a suitable gasometer, or is allowed to escape; the stopper in the other limb is fitted with a strip of platinum foil connected with the zinc pole of the battery, a small funnel tube and a right angle tube; the remainder of the apparatus is the same as the corresponding portions of that shown in fig. 1; the V

FIG. 2.



tube is immersed in water to prevent elevation of temperature. (1) The two instances in which this method was used were with the contents of the stomach and intestines in the Bishop case, and with the residues in the Cobb case (see p. 21); in both instances mirrors were obtained in the tubes, while a part of the arsenic was deposited on the platinum as a black stain; this plating seems to be rather an alloy of platinum and arsenic than a mere coating, or at least to become so after a time, as it was found (after having stood a month or more) to be not completely soluble in sodium hypochlorite, and neither completely volatilized by heat nor entirely oxidized when heated to redness in air. The relative proportions of arsenic deposited and evolved in its hydrogen compound varies with the strength of the current; in one instance a more powerful battery was used when the coating on the platinum was thick and very little arseniuretted hydrogen was given off, while in the other case in which a weaker battery was used the coating upon the platinum was light, but a heavy deposit was formed in the tube. In the Cobb case the the tube *b*. fig. 1, was filled with fragments of potassium hydrate in place of calcium chloride. It has been stated by Herrmann (2) and Dragendorff (3) that while antimoniuretted hydrogen is entirely de-

(1.) Since using the apparatus described in the text, we find it to be almost identical with that first suggested by Bloxam. Quart. Jour. Ch. Soc., XIII., p. 11; why he finally adopted the more cumbrous apparatus which he says was found to be more suitable, ib., p. 18, we are at a loss to determine. Although the method by the battery is usually known as Bloxam's, it was first described by Gaultier de Claubry in 1851. (Journ. d. Pharm. [3.] XVII., p. 125; and was also used in this city in 1860 in the case of Lydia Freeman.

(2.) Lehrbuch. d. Experim. Toxicol., p. 225.

(3.) Zeitsch. J. Anal. Chem., V. 200. and Gerich. Chem. Ermittelung d. Gifte, p. 51.

composed with the formation of a black deposit when passed over potassium hydrate, arseniuretted hydrogen is not effected under similar conditions. It has been found, however, by Prof. R. O. Doremus that the arsenical gas is decomposed, although, only partially, under these conditions, thus in the case under consideration there formed a black deposit upon the potash, especially upon the central portions of the cross section of the sticks. By subsequent experiment we have found that this decomposition is effected much more completely by the purer potash by alcohol, than by the ordinary potassa fusa, and in the case of the latter the presence of moisture seems to promote the formation of the deposit.

Residues B and C.—(See p. 15.)—These were either black or tawny (from an admixture of sulphur); they dissolved completely in hot dilute nitric acid, which proved the absence of mercury; the solutions were evaporated to dryness; the blueish residues were dissolved in water and treated with an excess of ammonium hydrate. In every instance the addition of ammonium hydrate was followed by the appearance of a blue color, indicative of the presence of copper, while in the case of Cobb a faint white precipitate also appeared, showing that the viscera contained bismuth in small quantity.

It will be remembered that Cobb had taken bismuth subnitrate as a medicine. A portion of this powder had been preserved and submitted for analysis. As is well known, arsenic is frequently present in this drug as an impurity; a quantitative determination was therefore made, which demonstrated that, although the medicine contained minute traces of arsenic, that element was not by any means present in sufficient quantity to account for the amount of arsenic separated from the viscera after death.

The presence of copper in the residue left by the evaporation of the ammoniacal solution of the sulphides, (residue C) was to be expected, as both the hydrate and sulphydrate of ammonium dissolve a much larger proportion of copper sulphide when organic matter is present than from purely mineral mixtures. (1). The amount of copper found as well in the urine of Cobb as in the tissues, was quite considerable, sufficient to form a plating upon a number of platinum capsules. A question now demanded solution, the determination of which would have been of considerable importance, had there been any suspicion that the poisoning might have been the result of suicide or of accident. Was the arsenic taken in the form of white arsenic, or as one of the arsenical greens? In a careful examination of the surfaces of the stomach and intestines, no fragments of green pigment, or crystals of white arsenic had been detected, and the quantity of arsenic obtained from the stomach was the merest trace,

1. In a subsequent analysis by one of us, the copper sulphide present was entirely dissolved by dilute ammonium sulphydrate, a nitric acid solution of the residue not giving the faintest blue tinge with ammonium hydrate.

almost the entire quantity of arsenic obtained had been absorbed or was in course of elimination. Apart, then, from the improbability that suicidal or accidental death from poison should occur without any weighable quantity of the toxic agent remaining in the stomach, there was up to this point in the analysis equally good reason for supposing that Paris green had been taken, as that the agent employed was white arsenic. It was only at a later stage of the examination, and by a comparison of the quantities of copper found in the tissues with that found in the residues from the Stas process that this question was decided (see p. 24). The amount of copper found in these residues, representing that portion which existed in the tissues in the *soluble* form, was exceedingly small. This state of affairs is that which we would expect would obtain if the copper extracted was that which exists, especially in the liver, combined with certain organic bodies as a quasi normal constituent, and having its origin in impurities or adulterants of articles of food. On the other hand, had the copper accompanied the arsenic and been absorbed along with it, it would beyond a doubt have existed in the tissues in a more soluble form, and consequently have made its appearance along with the arsenic dissolved from the tissues by the alcoholic fluids.

Other Mineral Poisons.—The filtrates separated from the precipitates formed by the action of hydrogen sulphide were further examined for such mineral poisons as would have remained in solution, zinc, chromium, barium, etc., in all cases with negative results.

Organic Poisons.—In most instances, for this portion of the analyses, the process of Stas as modified by Otto, and based upon the varying solubility of the alkaloids and their salts in water, alcohol, ether and amylic alcohol in the presence of an excess of acid or alkali, has been followed. It will be remembered (p. 10) that at the outset of the examination the parts were extracted with acidulated alcohol, with a view to dissolving out any alkaloid which might be present, the alcoholic fluids were allowed to evaporate until there remained an aqueous fluid, this was further diluted and filtered from the fatty matters which had separated; the filtrate was repeatedly shaken with ether, and the ethereal layers allowed to evaporate, the residue so obtained being designated as *Residue P*; the aqueous fluid was now rendered alkaline with sodium hydrate, and again shaken with ether, which, on separating, was removed and evaporated to yield *Residue S.*; finally, the aqueous layer was shaken with amylic alcohol, from which after separation and evaporation at a low temperature *Residue M.* was obtained. In this way a partial separation and purification of vegetable poisons was effected. *P.* would contain digitaline, colchicine, picrotoxine and oxalic acid if these were present in the substances examined. *M.* would contain morphine, and *S.* strychinine and the other alkaloids.

After suitable purifications, these residues were submitted to the special tests for the different vegetable poisons which they might contain. In neither case was any satisfactory evidence of the presence of the substances sought for obtained from Residues *P.* and *M.* Residue *S.* yielded negative results in the Bishop case, but evidence of the presence of strychnine in the Cobb case.

Detection of Strychnine in the Cobb Case.—In the search for this alkaloid, a variety of methods were used with the different parts examined, a short notice of which will not be out of place.

Contents of Stomach.—In these the Stas process was not used, but that recommended by Woodman & Tidy (1). The residue from the alcoholic extracts was dissolved in water acidulated with acetic acid, the solution filtered and evaporated, the residue again extracted with alcohol, filtered and evaporated; this residue was dissolved in water, the solution rendered alkaline with potash, and shaken with ether; the ethereal fluid when evaporated, yielded a residue, which, although only faintly bitter in taste and imperfectly crystalline, reacted plainly with the color test, giving a fine violet color, changing to red, then moistened with concentrated sulphuric acid and treated with a fragment of potassium dichromate.

Contents of Intestines and Bloody Fluid (2).—The examination of these is interesting, as affording a comparison of the relative merits of the Stas, and Graham and Hoffmann (3) methods. A number of pieces of freshly burnt animal charcoal were placed in the fluid faintly acidulated with tartaric acid, after an immersion of ten days the charcoal was removed, washed with a small quantity of water and boiled repeatedly with alcohol; the alcoholic extract was evaporated and the residue after purification was carefully tested for strychnine with sulphuric acid and dichromate, as well as by the method suggested by Letheby (4), without the appearance of any violet or red color; the residue was neither bitter nor crystalline. After the removal of the animal charcoal, the fluid was subjected to the Stas process as above described; the *S.* residue which was imperfectly crystalline and faintly bitter was, after purification, tested for strychnine; Letheby's test gave no indication, but with sulphuric acid and dichromate a deep violet color was produced which slowly changed to red and finally to yellow.

Kidney, Liver and Heart.—The *S.* residue obtained from these by the Stas process, also gave the characteristic color changes when tested for strychnine.

Having thus obtained unmistakeable evidence of the presence of strychnine in the body of Cobb, both in the alimentary canal and

(1.) Forensic Medicine, p. 309.

(2.) This fluid was a mixture of blood, etc., collected from the jar in which the solid viscera had been sent.

(3.) Quart. J. Chem. Soc., 1853, p. 173.

(4.) Lancet 1856 (June,) p. 708.

absorbed in the tissues, a question arose very similar to that which demanded solution in the case of the arsenic: Was the strychnine which we found administered as a poison, or was it the remains of a medicinal dose?—a question upon which the trial would probably have turned had no other poison been detected, for one of the physicians in attendance upon the deceased had administered strychnine, as indicated in the prescription given on page 5. And in the absence of contrary proof, it would have been simple justice to ascribe the strychnine found in the body to this source. The bottle containing the remains of the medicine had been submitted for analysis. A quantitative analysis showed that it contained the proportion of strychnine (and no more) that the prescription called for. The bottle still contained one-half of the fluid, Cobb had, therefore, taken medicinally ½ grain of strychnine in several doses of 1-32 grain each; and as this administration had continued through several days, during which elimination was also taking place, it is highly improbable that more than a small fraction of a grain of this strychnine should remain in the body at death, and still more improbable—nay, impossible, that this small quantity, distributed throughout the body, could have been successfully extracted and yield such clear results. We are of the opinion that, notwithstanding the known administration of strychnine in medicinal doses, its detection in the tissues of the body would go far to confirm other evidence of its having been taken in poisonous doses. In the present case, Bishop confessed that he had advised Mrs. Cobb to give her husband a poisonous dose of strychnine at this time, on the ground that, owing to its medicinal administration, the chances of discovery would be small. Contrary to the results in the case of arsenic, the contents of the stomach gave the most decided evidence of the presence of strychnine, which would obviously indicate that while the dosing with arsenic had stopped, strychnine had been taken by him a short time before his death.

Alkaloids in the Bishop Case.—In this case no evidence of the presence of any vegetable poison was obtained, although, according to Bishop's confession, she had been poisoned with morphine. If this be true, it is probable that the victim lived for a sufficient length of time after the administration of the poison to allow of its removal from the body by elimination.

Examination of Residues for Mineral Poison.—We have already pointed out (p. 11) that in the method which we have followed a separation, more or less complete, of soluble from insoluble mineral poisons occurs at the outset, and that the former are to be sought for in the residues of the Stas process from which the alkaloids have been removed. These residues were in both cases treated for mineral poisons by the method already described. In the Cobb case the

amount of copper was, as has already been stated, exceedingly small. The purified arsenical liquor was divided into two equal parts, one of which was treated with hydrogen sulphide, after reduction of the arsenic acid to arsenic trioxide, when a copious bright yellow precipitate was obtained, which was reserved as an exhibit. The other half was again divided into two equal parts, one of which was reserved: the remaining quarter of the original fluid was introduced into a Marsh apparatus, hydrogen being obtained from the decomposition of water (fig. 2): a black deposit was formed upon the platinum, while in the tube a fine large mirror of arsenic was obtained: the solution of silver nitrate through which the escaping gas bubbled had blackened, and upon the addition of dilute ammonium hydrate produced a faint yellow ring at the junction of the fluids, indicative of the presence therein of a small quantity of arsenic trioxide, showing that, although the current of gas had been exceedingly slow and the heated surface had been great, a portion of the arseniuretted hydrogen formed had escaped decomposition. A greater quantity of arsenic had thus passed into the alcoholic solution than was obtained from the solid portion of the tissues, a fact which demonstrated that the arsenic had been present in a form soluble in alcohol, and also showed the importance of an examination of these residues.

Quantitative Results.—During the trial of Mrs. Cobb for the murder of her husband, the counsel for the defense used their best endeavors to impress the jury with the minuteness of the *quantity* of arsenic extracted from the body of the deceased. In cases such as this, where the poison is almost exclusively absorbed, there seems to be a great temptation for the legal fraternity to insist upon this point, notwithstanding the fact that writers upon toxicology are unanimous in stating that the quantity found can be no indication whatever of the quantity ingested, and that all that is required of the expert is to show clearly and conclusively the *presence* of the poison. Not only is it impossible to determine by analysis after death how much poison the victim took, there are also serious, not to say insuperable, obstacles in the way of determining the quantity actually in the body at death. We may determine, although not with absolute accuracy, how much of a given poison exists in an organ, the liver, for example, but from this we can only estimate in a very rough way the quantity in the entire body, and to determine this quantity accurately would, as Wormley [1]) remarks: "require an analysis of the entire body and a recovery of every atom of the poison from that complex mass—the first of which is impracticable and the second impossible."

Nevertheless, there arise in many cases collateral questions of almost as great importance to justice as the main issue, upon

(1.) L. c., p 52.

which much light may be thrown by as accurate a quantitative analysis as possible, to determine the absolute quantity of poison present, and to afford a basis upon which to establish a comparison of the relative amounts existing in the various organs.

There are quite a number of methods for determining the quantity of arsenic in use among chemists, which, although sufficiently accurate for ordinary analyses, leave much to be desired when such small quantities as usually occur in toxicological investigations are to be estimated. We had hoped that M. A. Gautier had succeeded in finding in the Marsh-Berzelius process, when conducted with certain precautions, (1) a method by which *all* the arsenic present in the substances examined might be separated and estimated; unfortunately, however, in the attempts which we have made to satisfy ourselves of the accuracy of the method we have in every case failed to obtain satisfactory results, and consequently we must adhere to the view hitherto held by chemists, that the totality of the arsenic introduced into the Marsh apparatus is not obtained in the mirror, at least until M. Gautier's results have received further confirmation. (2)

The process which we consider most satisfactory and which was followed in these investigations, is that in which the arsenic is weighed in the form of the trisulphide. The liquid obtained by dissolving the mass of sodium sulphate, sodium arseniate, etc., (see p. 15) is treated with sulphur dioxide to reduce the arseniate to an arsenite, and then precipitated with hydrogen sulphide as already described; the arsenic trisulphide (usually contaminated with sulphur) thus obtained is collected upon a filter, washed, dried, thoroughly washed with carbon disulphide, dried and weighed; then treated with ammonia and the filter again washed, dried and weighed; the loss of weight between the last two weighings being taken as that of the arsenic trisulphide present.

Upon the trial the expert called by the defense, Prof. S. W. Johnson, of Yale College, took exception to this mode of procedure on the ground that the results obtained might be too high; the process as we used it differs, however, from that recommended by Frezenius (3) in two particulars only: 1st. In weighing the precipitate directly upon the filter, in place of evaporating the ammoniacal solution upon a watch glass and weighing the residue; a distinction of convenience only, for although a glass vessel may be more rapidly dried than a filter, yet, if two successive weighings of the latter with an intervening drying of half an hour at 100° C. be identical, all moisture has certainly been expelled. (4). 2nd. Frezenius says,

(1.) Bull. d. l. Soc. Chim. d. Paris. XXIV. 250.

(2.) We are at present engaged in further experiments upon this question, which we propose to make the subject of a separate communication. We are aware that M. Crommydis has obtained results which agree with those of M. Gautier. See Bull. Soc. Chim., Paris XXV. 348.

(3.) Johnson's Translation, pp. 348 and 349.

(4.) See Puller. Zeitsch. f. Anal. Chim., X., p. 41.

"The final weight represents the quantity of arsenious sulphide, *if upon subsequent reduction this is found to be pure*;" (1) how such proof of the purity of the sulphide is to be obtained we are, however, at a loss to understand, for as Prof. Johnson himself states in a note to Frezenius, "according to Rose and Mohr, the reduction of the arsenic is never complete, and when excess of sulphur is mixed with the $As_2 S_3$ no metallic arsenic can be made to appear." (2)

In the Cobb case the following determinations of quantity were made :

	$As_2 S_3$	$As_2 O_3$
Tissue of Stomach and Intestines	0.0051	0.0041
⅓ Liver and ½ one Kidney	0.0024	0.0019
½ Liver, Spleen and one Kidney	0.0028	0.0023
Urine, 110 cc	0.0036	0.0029
Residues (mineral)	0.0049	0.0039
Residues (organic)	0.0084	0.0068
Muscle (335 grams)	0.0012	0.0010
Total grams weighed	0.0284	0.0229

In the Bishop case only one sulphide was weighed ; it was obtained from one quarter of the tissue of the stomach and intestines, and weighed 0.0008 gram., corresponding to 0.00064 gram. $As_2 O_3$.

For deductions drawn from these quantities see p. 38 et seq.

Purity of Reagents.—We need scarcely state that the greatest care was had that the chemicals used should be of such purity as to preclude the possibility of any contamination through them of the viscera with those substances whose presence or absence was to be determined by the analysis. The reagents most liable to contamination with arsenic are zinc, and hydrochloric and sulphuric acids. it is, however, possible to obtain these substances to all intents and purposes free from arsenic. Otto (3) recommends that in determining the purity of zinc and sulphuric acid the testing be continued for at least half an hour ; Prof. Johnson (4) considers ten to fifteen minutes sufficient, we do not think, however, that any materials yielding a stain during a testing of two hours are sufficiently pure for toxicological uses. (5)

In addition to the special testing to which the reagents were subjected before use, we had other reasons to be satisfied as to their

(1.) L. c., p. 348. The italics are our own.
(2.) L. c., p. 187.
(3.) L. c., p. 115.
(4.) Note to Frezenius, l. c., p. 184.
(5.) The German acids we have always found to be arsenical. In an analysis recently conducted by one of us five samples of so-called pure sulphuric acid were examined before a pure article was obtained from a Philadelphia manufacturer.

purity: 1st. In testing some Swedish filtering paper it was subjected to the same processes as were the organs examined, large quantities of the same chemicals being used, without the appearance of the faintest arsenical mirror after a heating of two and a half hours; 2nd. In three other investigations in which chemicals from the same stocks were used no arsenic was found; 3d. In those cases in this analysis in which the greatest quantities of reagents were used the least amount of arsenic was found.

PHYSIOLOGICAL.

Having recounted the steps taken and the results obtained in the chemical analysis, we are now prepared not only to compare the two cases, but to institute some inquiry regarding the distribution of poisons in the economy, the various parts most likely to become saturated, and to speak of some new phases in criminal prosecutions that are likely to become important points in the arguments of counsel for the defense. In enumerating the various parts of the human body requisite for the chemical investigations, we stated the necessity of preserving the alimentary canal intact, and that in addition to these organs, others should be preserved through which the poison would pass in the processes of absorption and elimination. Frequently some of the poison remains in the stomach and intestines, either because of its peculiar form, or because the time elapsing between its ingestion and the death of the victim was insufficient for its solution by the digestive fluids, or its absorption by the mucous membranes, or ejection by vomiting.

Referring to the analysis of the remains of Mr. Cobb, it will be seen that the quantity of arsenic extracted from the contents of the stomach and of the intestines was small, though the tissues of these organs yielded a large amount. The analysis also demonstrated that arsenic was removed from these parts by the alcohol employed to extract the alkaloids, and this solvent acted more completely, no doubt, on the contents of the stomach and intestines than upon the tissues of these organs, or of that of the liver, though this would apply more to the case of Cobb, whose stomach was full of undigested food, than to that of Mrs. Bishop, where that organ was found empty. Nevertheless the acidulated alcohol removed a portion of the arsenic from the liver, for turning to p. 27, and comparing the quantities of arsenic respectively obtained from one-third of the liver and half of one kidney, with that from half of the liver, the spleen and one kidney, in the latter instance, though the arsenic was in excess, yet this excess was not proportional to the amount of tissue operated upon. The method of analysis differed only in one

particular, viz., that before dissolving the larger portion of tissue in hydrochloric acid and potassium chlorate it was subjected to a protracted digestion in acidulated alcohol, the alcohol being then separated from the insoluble by filtration. We may assume then as a positive result that arsenic was removed from each portion of the remains treated by alcohol, though we have no direct evidence as to the quantity yielded up by each organ; this is unfortunate, but the step of looking for metallic poisons in the alcoholic extract was a new departure, and experience will surely dictate modifications in the method. Hereafter it would be highly advisable to examine the residues left in the conduction of the Stas Otto process from each portion so treated, and by this means gain more accurate knowledge of the relative distribution of the toxic agent in the system. Notwithstanding this possible cause of error we are justified, we think, owing to the results obtained from parts untreated by the alcohol,* in regarding the case of Mr. Cobb as one in which the arsenic was administered quite a time previous to death, and as one in which there was sufficient time for the poison to permeate the entire system during a continuance of all the vital functions. The greater portion of the viscera were removed from the body before burial and only such parts were placed in the one glass jar as would naturally lie near each other in the body. Brain, muscle and urine were subsequently removed and kept separate. We are therefore furnished with ample data from which to trace the course of absorption and elimination; nor are we in want of similar proof in the case of Mrs. Bishop as regards the relative distribution of the deadly agent; indeed this case seems to supplement the other, a complete concordance being established.

Toxicologists rarely have to note a departure from the principal mode of administering a poison, viz., by the mouth, though records may be found where the skin, vagina, urethra or rectum have been the channels through which the poison was introduced. We recall two cases, examined at Bellevue, and occurring at about the same time, in one of which the poison was absorbed by the vagina, and in the other by the male urethra. Through the skin two modes of administration are possible, either by external application, or by hypodermic injection. Arsenic frequently produces the same irritation and local congestion of the gastro-enteric membranes, when absorbed from remoter parts, as when applied directly to these tissues; indeed this is claimed as a special characteristic of this form of poisoning. ut given a case where the administration is known to have taken place through the mouth and death has ensued, small quantities of the arsenic being detected by *analysis*

* We instance that portion of the liver and kidney already alluded to, and the urine, brain and muscle.

in the contents of the stomach and intestines, the chemist will probably be asked how long before death the poison was taken? When the mode of access is unknown or uncertain, a second question will naturally suggest itself: By what channel did the arsenic or other poison enter the body? These queries, though pertinent and at times of greatest import, are by no means always answerable. We specially intoned the word analysis, since the finding of suspicious particles, crystals, seeds, etc., in the stomach indicates positively that the poison was taken by the mouth; the question of time of sojourn in the digestive tract is the only one then to be decided. The case is different, however, when the poison is found only on a chemical treatment of the contents of this organ, and not by a mechanical separation simply; in the first instance the foreign substance may have been already once absorbed by the tissues, and when detected be in process of elimination by the very parts it has first traversed. Physiological experiments have long since shown that abnormal substances are thrown out of the system by many channels, and the analysis of almost all the fluids of the body in different cases of poisoning has demonstrated the presence of these foreign materials. The process of elimination is by no means constant, however; with one and the same poison the size of the dose is not only influential, but one means of exit may become clogged, and force the system to rid itself of the poison by other channels, the simple diminution of the quantity caused by elimination may exert enough influence to cause a variation in its further excretion by one organ, others then functioning. All glandular structures, then, are more or less influential in the excretion of poisons, subject however to the nature of the poison, its quantity, mode of ingestion, etc. The glands that secrete the gastric juice form no exception, and records exist showing that arsenic may be found in the contents and tissue of the stomach though the cause of the poisoning was the application of an arsenical paste to the skin, or its introduction through other orifices than the mouth.

The detection of arsenic in the bile in the case of Mrs. Bishop strengthens the proposition that the sources of elimination are as many as the secretory and excretory organs. The intestines are perhaps the most likely source from which to extract the poison, since they not only receive much of the poison directly from the stomach, but are the receptacle of numerous fluids secreted by the largest and most important glands in the body.

It follows from these facts that instances may occur in which, from an examination of the stomach and intestines and their contents, little or even no insight may be gained regarding either the mode of administration or the time of the victim's survival. We are obliged in such cases to extend the examination to other organs.

either to confirm or to contradict the evidence presented by the alimentary tract; this course, though always advisable, is under the above circumstances absolutely necessary. The question now arises: Which organ or organs shall we employ to verify the conclusions drawn from the analysis of the stomach and intestines? Until very recently, toxicologists were agreed that the liver was preeminently suited for such investigation, and we hope to demonstrate from the facts in the Cobb and Bishop analyses, that there is no reason for departing from this opinion.

In this regard these two analyses are remarkably complementary, the evidence of the one taking up the story of elimination where the other left off. In the investigation of Cobb's remains, two separate analyses of the liver were made — one in which one-third of the liver and half of a kidney were operated on together, and another in which one-half the liver, the spleen and one kidney were brought into solution. In the Bishop analysis a portion of the liver was examined by itself; another portion, along with a kidney and a piece of muscular tissue; and the gall bladder and its contents were made the subject of a third research. Every one of these analyses gave positive results as regards the presence of arsenic We instance particularly, however, the first analysis in the Cobb case, and the analysis of the gall bladder and bile in the Bishop case. It is therefore apparent that the liver not only receives the poison as it is absorbed from the digestive tract, but also separates the foreign body from the blood, preparatory to its elimination by the bile. This fact stands in perfect accord with what is now known regarding the liver as an excretory organ, and it should be a matter of no surprise to find that poisons may be and are detected in the hepatic secretion.

As from the liver, so also from the kidneys, we may expect to obtain evidence of a poison, not only in the tissue of the organ, but also in the product of its natural functioning. Although but a small amount of urine was obtainable from Cobb's remains, that quantity was sufficient to show plainly that the arsenic was in process of elimination. Finally, such remote parts as the muscular tissue and brain gave positive indications of the arsenic they contained. Although cases have occurred in which no poison was detected in one or more of the parts of the body which we have mentioned, or in different proportion than found in these instances, yet, in the great majority, questions of doubt as to the manner and time of absorption of the poison will be removed by an analysis of the internal organs in the order suggested above.

It seems to be less of a habit in this country than abroad for a physician called to attend the sick and the dying, to preserve the vomit, fæces, or urine, when suspicion of poisoning is bruited about, or even only suspected by himself, the chemist is consequently obliged to look

for some internal evidence regarding the excretion of the poison, if there be any detected. To be able to demonstrate on the trial the fact that a poison was not only absorbed by the animal tissues, as the finding of it in various organs would be convincing, but furthermore, that through the physiological action of certain parts the poison was seeking an exit, may be of the highest import to the prosecution. In acute poisoning, then, the chemist may sometimes be satisfied with an examination of the digestive tract; in supposed chronic cases, the more complete research is absolutely necessary; and indeed in either case justice to the accused demands it.

Distribution of Poisons through various organs.—We have considered the question of the advisability of analysing other parts of the human frame than those which are usually the direct recipients of a poison, and seen that we may expect to find it in other tissues and in various fluids of the body. We may next institute an inquiry regarding the special values of particular tissues; first, as to their relative value, next as to the quantity of poison each may contain.

As recorded in the description of the chemical processes followed in the analyses of the remains of Mr. Cobb and of Mrs. Bishop, not only the stomach and intestines and their contents were subjected to analysis, but also the liver, spleen, heart, kidneys, urine, blood, bile, muscle and brain.

It was impracticable to make analyses of each of these parts separately; care was taken, however, to arrange them into groups, each group representing in a measure a stage in the transit of a poison through the economy. Thus stomach and intestines were examined together; liver, spleen, heart and kidney. The urine, bile, muscle and brain were, however, separately analyzed. Tabulated, we have

CHARLES H. COBB, JR	HATTIE E. BISHOP.
Inorganic Poisons.	*Inorganic Poisons.*
Contents of the stomach.	Contents of stomach* and intestines.
Contents of the intestines, and blood exuded from various organs.	Tissue of stomach and intestines.
Tissue of stomach with that of intestines.	Liver.
One-third of the liver with half a kidney.	Liver, kidney and muscle.
One-half the liver, spleen, and a kidney.	Kidney, heart, muscle and spleen.
Urine.	Liquid extract of organs, mixed with some blood.
Brain.	Bile.
Muscle.	Brain.

*In default of contents, the washings were taken to represent them in this case.

Organic.	*Organic.*
Contents of stomach.	Contents of the intestines.
Contents of intestines and exuded fluid, by Graham-Hoffman process.	Tissue of stomach and intestines.
Contents of intestines and exuded fluid, by Stas-Otto process.	Extract from brain, heart, kidney, spleen, muscle; that of tissue of stomach and intestines subsequently added.
Liver, spleen and kidney.	
Liver, kidney and heart.	

Arsenic was detected in all the parts of both analyses.

In the Cobb analysis, strychnine was detected in the contents of the stomach, contents of the intestines (by Stas-Otto process,) and in the extract from the liver, kidney and heart.

No alkaloid was found in the remains of Mrs. Bishop.

Comparing the results obtained a very clear idea is gained of the distribution of mineral poisons in both bodies, and of strychnine in that of Cobb.

Although the separation of the metals from the various organs was a subject of research even in the earliest toxicological investigations, and proof has again and again been obtained of the presence of these abnormal substances, not only in all the various tissues from the skin to the bones, but in the fluids of the body, from surface blisters to the secretions of the innermost organs, yet it has never been decided which portions, if any, of the human frame become the depositories of any special poison, nor have the analytical results shown even a correspondence in the amount of any one metal, though extracted from one and the same organ under like circumstances of poisoning. Much necessarily depends on the amount of poison taken, the mode of its introduction, and the length of time intervening between its introduction and the time of death. Much has been written of late upon these subjects, of great medico-legal interest, and in some instances radically changing accepted views, especially concerning the imbibition of poisons by the dead body, or the post-mortem injection of poison into the remains, with or without sinister intent. As in the cases in hand we are principally concerned with arsenic as the toxic agent, we confine ourselves to that body in the discussion of these matters. Fortunately, there exists no poison so easily detectable, nor any upon which more extended research has been expended. We are therefore dealing with a department of the science whose literature is most abundant. Taylor,* in his last edition, makes the following statement, which fairly represents our present knowledge:

"In recent cases of administration, it may be found in the stomach and bowels, and not in the liver or other organs, while in cases of older date it may be found in the liver, after it has disappeared en-

*Taylor op. cit., p. 42. Dragendorff p. 32

tirely from the stomach. * * * The kidneys, spleen, heart, lungs and brain, and after these organs, the muscles and bones, are also seats of deposit, and the proportion deposited, so far as it is yet known, is in the order in which these parts are mentioned."

Dragendorff also points out the probable distribution thus:

"Man hat noch nicht sicher nachweisen können, dass einzelne Organe des Körpers das Arsen mit besonderer Vorliebe aufnehmen oder festhalten. Das steht aber fest, dass es sehr leicht ins Blut übergeht und mit diesem durch den ganzen Körper verbreitet wird. Vielleicht, dass auch die Leber schnell einen Theil des Giftes in sich aufnimmt."

The presence of arsenic may be revealed in any organ or fluid of the body, but we are less concerned with this universal distribution through the system than with the relative proportion that may be expected in the various parts. Elaborate researches, too, have been made, and comparisons instituted to determine the maximum amount that any single organ can retain, and also in regard to the length of time it is held after the ingestion of the poison, those of Dr. Geoghegan† being frequently cited.

It appears from all these facts that whether in acute or chronic cases of poisoning, the liver is, *par excellence*, that viscus that is likely to yield affirmative results. In opposition to this view we have a series of experiments and analyses instituted by M. Scolosuboff* in 1875, from which it appears that in the lower animals much more reliable and exact evidence of the presence of arsenic may be obtained from the brain and spinal cord than from other tissues; and further, that the amount of the deposit, and the speed of its deposition in those organs are much greater than elsewhere.

Reese, in an important paper, read before the College of Physicians of Philadelphia in 1876, calls especial attention to these experimental results as offering in cases of supposed post-mortem imbibition, a means by which this all-important question can be solved by the chemist. We quote his views: "I am not aware that it has yet been verified in man, although there seems good reason to believe that it will equally apply to the human subject. Should this prove to be the fact, we shall be in possession of a positive and unequivocal chemical method of distinguishing between ante-mortem and post-mortem poisoning by arsenic (and probably by other metals), by the detection of the poison in the brain and spinal cord; since it is scarcely conceivable that a poison introduced into a body after death could penetrate by imbibition within the cavity of the cranium or spinal column. At all events, it will henceforth become the duty of the expert, in all doubtful cases, to extend his researches for the poison to the brain and spinal cord."

*Archives de Physiologie, No. 5, Août et Septembre, 1875.
Bull. Soc. Chim. XXIV., 124.
†Taylor op. cit. p. 40.

The record that we have to make in regard to the analyses of the brains of both Mr. Cobb and Mrs. Bishop is a peculiarly interesting feature of this report. With the views of both Scolosuboff and Reese in mind, pains were taken at the autopsy of Mrs. Bishop and on the second examination of Mr. Cobb's body to secure the brains of each. In the case of Mrs. Bishop this was easily accomplished, for as soon as it had been examined by the medical gentlemen conducting the autopsy, it was removed from the skull and placed in a glass vessel. At the first post-mortem examination of Mr. Cobb's remains, the cranium had been opened and its contents removed for inspection. The brain was afterwards placed in the abdomen instead of being returned to the cranium, the former having been emptied and its contents sent for chemical analysis. When the second post-mortem was held, the abdomen was again opened, and as much of the brain removed as appeared free from any contamination from the walls of the cavity or any fluids that it might contain; a portion only of the brain was therefore obtained, but this was ample for the analytical research. Outwardly there was but little difference in the appearances of the organs.

The chemical treatment employed to detect any metallic poison was the same in both cases, as has been shown in the section devoted to the processes of analysis. The tissue yielded with difficulty to the solvent action of the acid, but at last a solution was obtained that was deemed satisfactory. Large amounts of acid were used, and a correspondingly large amount of chlorate. Only traces of arsenic were extracted from either brain—sufficient to get reactions, but by no means in such quantity as the investigations of Scolosuboff would lead one to expect. He found that the nerve tissue of the lower animals contained at least thirty times as much as the liver or muscle. In the case of Mr. Cobb, we obtained weighable quantities from both those parts, and in the case of Mrs. Bishop, from the liver and stomach; but in neither instance was the amount of arsenic extracted from the brain more than a mere trace. These results acquire additional value from the fact that they were derived from two probably typical forms of arsenical poisoning, one in which the administration spread over considerable time, while in the other death resulted soon after the first dosing.

We offer no conclusions as yet, for it would be very hasty to generalize from what we find to be the fact in two analyses only; but the result leads us to believe that no such localization of arsenic can be looked for as would be inferred from the above citations. What bearing this will have on cases of supposed imbibition we will notice hereafter.

One word here upon a matter of medical testimony raised in the record of Cobb's symptoms by Dr. Carleton; briefly stated, it was

whether the symptoms arose from what is usually termed "*chronic*" poisoning, or whether they were not produced by the successive administration of large doses, with quite a period of time intervening, so that the system had almost recovered from one before it was seized with another attack, in other words, not chronic poisoning, but a succession of acute shocks. As this comes under the head of the medical rather than the chemical history of Cobb's illness and death, we note the matter simply, and allow our friends, the physicians, to discuss the question.

But while the results of the analyses of the brains contradict rather than confirm these latest inquiries into the localization of poisons, the matter is far different with the facts collected from the chemical examination of the internal organs, and their secretions or excretions. As we have quoted, the liver appears to demand the greatest attention. What do these analyses tell us regarding this viscus? In both the Cobb and Bishop cases, large mirrors of arsenic were obtained by the Marsh process, and in the Bishop case the same test revealed in the bile no less conclusively the presence of arsenic. It has long been claimed that the liver affords a domicile for metallic poisons, and that once safely housed, they are ejected with great difficulty.

Two facts are made prominent by the analysis of the liver of Mr. Cobb on the one hand, and of the gall bladder and bile in the remains of Mrs. Bishop on the other, viz., that in the former a notable portion of the arsenic was extracted by the use of acidulated alcohol, and in the latter that the amount of arsenic obtained from the bile nearly equalled that obtained from the entire liver. These are strongly corroborative of each other. From the first we learn that the arsenic was present in a condition that did not interfere with its solution; from the second that through the physiological function of the liver the arsenic was in process of elimination.

Some chemists recommend the digestion of the liver in weak acid to remove any arsenic it may perchance contain, and some suggest this process as being of vital importance in distinguishing cases where, though arsenic be found in the remains, it entered the body in one of its insoluble forms. The extraction by acidulated alcohol possesses the advantage of not only separating the poisonous from the non-poisonous forms of arsenic, but of being also the first step in the detection of any alkaloid.

The bile has in previous instances been subjected to chemical investigation in cases of arsenical poisoning with successful results. What we wish to bring forward especially is the fact that the liver becomes of paramount importance to the toxicologist in his search for poisons, as demonstrating not only the absorption but the elimination of the toxic.

The desirability of keeping the liver separate from other organs, especially the alimentary tract, is at once apparent when we consider that in default of vomit, faeces, or urine, this organ and its secretion would afford proof of elimination. The same holds equally true with regard to absorption.

We are aware that certain metals, as lead and copper, are seemingly more pertinaciously retained in the liver than others, such as arsenic or antimony; but may not this apparent retention be largely if not entirely due to a renewal in the supply of these metals from the same source that introduced the portion first deposited? We frequently find copper in the stomach and intestines as well as the liver, and the general opinion regarding the presence of copper in the human system is that it is not a normal constituent, but of accidental origin. With arsenic or antimony no doubt the process of elimination is more rapid, but then too the dosing is soon stopped. We do not mean to say that by passing through the hepatic tissues the poisons do not enter into chemical union with the organic principles there present, we only claim that such compounds do not accumulate; this is well illustrated by the fact that if sufficient time elapses between the ingestion of the arsenic and death none of the poison can be found in the liver. The experiments of Dr. Geoghegan, already referred to and others, prove this conclusively.

There is still another reason why the liver is so apt to respond to tests in the search of poisons, namely, that the outlet for the bile being the intestines, if these are in any way obstructed, the poison is at once reabsorbed and carried back again to the liver through the portal circulation. It may therefore take considerable time for the poison to pass out of the system. This may explain in part the variations found to occur in the elimination by the kidneys, variations oscillating even to total disappearance of the poison for a period.*

If on analysis the liver should fail to reveal the presence of any poison, we would naturally push our inquiries further, seeking to obtain information from the blood, heart, kidneys, muscular tissue, or brain. That such a course is only necessary when we have failed to detect poison is not to be inferred, since the chemist would do well to protect his analysis from invidious criticism by making its results so clear and demonstrative that to cavil at them were impossible.

As we have stated, it has generally been the custom to conduct the analysis of the viscera in such a way, that instead of a separate determination of the amount of poison in each organ, the material is so divided that we may trace first the ingestion, next the distribution through the system, and lastly the elimination. We

* "Importance of Chemical Analysis in Cases of Obscure Diagnosis." Buffalo Medical Journal, 1879. C. A. DOREMUS.

would strongly recommend that the more complete, though laborious method of many separate analyses be followed, for reasons that will be apparent when we speak of the subject of post-mortem imbibition, as well as for other reasons.

Quantity.—Next to the question of whether a poison has been found, and if so, how distributed, is the one asked by all lawyers, an answer being demanded by most juries, "How much was detected?" It is hard to impress the fact that that part of the poison that killed may have passed out of the body, and that the surplus only remains to be detected by the chemist. The poison found in the stomach is more frequently of value for the determination of some collateral point than as proof of death by poison.

It is the exception to find the poison lodged in the alimentary tract. Nor can we argue from having found a poison so enclosed that a portion of it had been absorbed and had produced death; an investigation of the deeper tissue may entirely contradict such an opinion. Authors on Toxicology unanimously regard the determination of the quantity remaining in the tissues as of secondary importance to the main fact—the presence of the toxic; yet we can conceive a case where a knowledge of the relative distribution as shown either by the arsenical mirrors, or copper platings obtained from the several parts of the system by the same analytical method may lead to important conclusions in connection with the symptoms and with the circumstantial evidence of the administration of the fatal dose.

We may therefore require a quantitative analysis, or at least a proximate estimate, to compare amounts held by the various organs, both of metallic and vegetable poisons. When, as in this trial, two bodies are subjected to chemical examination, a comparison of the one with the other may be instituted. At the very threshold we are met by an almost insurmountable obstacle, viz., the reliability of the chemical methods for the extraction of *all* the poison remaining in each tissue at the time of death. We have to deal with minute quantities diffused through the most complex mass and so associated with organic matter as to evade many of the most accurate tests that can be applied to simple solutions of the metals. When an alkaloid is to be looked for, its extraction and purification are extremely difficult.

No one, we think, will claim therefore to be able to separate the totality of the poison; a loss always occurs. Though the qualitative reactions of some poisons are exceedingly delicate, they frequently fail to give accurate results when applied quantitatively: we are driven therefore to less delicate though for quantitative work surer processes; the zeal with which chemists have sought to render the Marsh test applicable to a quantitative research admirably illustrates this point Again, we are sometimes obliged to choose be-

tween two modes of separation and accept the less accurate because of its being better adapted to the general procedure of the analysis. Thus it is no inconvenience to determine in a case of arsenical poisoning the weight of the sulphide, since a separation of arsenic as sulphide is one of the steps of the analysis, yet many consider the method of its determination as pyro-magnesium arseniate as far more accurate. Then, too, we are frequently forced to adopt what is the less accurate method where abundance of material is at hand to be weighed, because it becomes when dealing with small quantities the more reliable.

It would seem from this that the causes of error are so many and so great that no real knowledge of this part of the chemical work could be gained, for we have first, a loss due to the imperfect separation from the complex mass; secondly, to the inability to apply the most refined tests used to detect poisons, loss here occurring through insufficient means of separation; yet notwithstanding these facts we may still gather all necessary evidence. Indeed some authors claim that where traces only are found, no accusation should proceed from the chemist. We beg to differ from such an opinion.

Record there is of cases where, though poison was known to have been given, the chemical analysis, most carefully conducted, could not detect any portion of it in the viscera. The experiments of Geoghegan, quoted by Taylor and mentioned on page 104, demonstrate not only the fact that arsenic may disappear from the system, or at least from the liver, but record the probable time of such complete elimination. What shall we say therefore of the presence of minute quantities? That the purity of the chemicals is thoroughly established is of course understood. Apropos of this question, Taylor* says: "Absorbed arsenic, as it exists in the tissues, is never found except in minute proportion, a proportion commonly insufficient to destroy the life of another. Hence, whether much or little is detected, the question is misleading, since the fact of death having been caused by poison does not, in the least degree, depend upon the precise quantity which happens to remain in a dead body."

It should be a matter of no surprise therefore, if we speak of the thousandth of a grain, or even the ten-thousandth. Turning to page 27, it will be seen that in the analysis of Mr. Cobb's remains seven weighings were made of the extracted arsenic. Of these, two cannot enter into any calculation of the relative distribution, they being residues of poison collected from various tissues. Of all the single weighings that of the arsenic obtained from the tissues of the stomach and intestines indicated the greatest quantity, though if we add together the two separately determined from the liver, spleen and kidneys, we find a slightly larger amount. But from all of these tissues

*Op. cit., p. 159.

the alcohol removed much arsenic, and we can scarcely say what relation exists between the tissues of the alimentary tract and the deeper seated organs, unless this enter also into calculation. We can, we believe, fairly assume that the liver contained the greater quantity, since we have very direct evidence of the solvent action of the alcohol. The third of the liver and half a kidney gave 0.0028 gram, As_2S_3, while the half of the liver, the spleen and a kidney first treated with alcohol gave only 0.0024 gram sulphide. Evidently the arsenic was extracted to a goodly extent.

Furthermore, this view is corroborated by the large amount of arsenic (0.0029 gram) obtained from the 110cc. of urine. The quantitative estimation of arsenic in the muscles gives a basis of calculation regarding the amount distributed through the body, if there is ever any such basis. When the question was pressed at the time of the trial as to the probable amount of arsenic in Cobb's body, it was distinctly stated that *any calculation* must needs be an imperfect one. From the amount obtained from the liver we cannot reason regarding that to be obtained from the heart or kidneys; we might assume, however, that each kidney retains an amount of the poison equal to the other, or that the poison is evenly distributed through the muscular portion of the frame. As in a human body weighing 154 pounds, there are calculated to be 68 of muscular tissue and appurtenances, and as from 335 grams of muscle from Cobb's thigh 0.001 gram of As_2O_3 was obtained, there would result about 0.08 gram As_2O_3, or 1.25 grains of white arsenic in the muscular tissue, taking 60 pounds as the basis of calculation, a reduction of weight being allowed since Cobb was, though 6 feet high, much emaciated. Such an assumption, though not rigidly correct, is proximate to the real state of the case. A rough calculation may be based on the weight of bodily tissue analysed, and from the quantity of poison found *absorbed* in twenty or thirty pounds, we may argue that from the one hundred and twenty or thirty pounds we could extract five or six times as much. To simply state the weight would in some instances be sufficient; in many cases, however, such simple statement would be unjust and depreciate the value of the analysis greatly. In the Cobb case we gave the sum total of arsenic weighed, then calculated an additional quantity extracted but not weighed from the size of the mirrors, or the bulk of the sulphide precipitates, and to these two was added the probable quantity remaining in the body of the deceased. If we add together all the amounts of arsenic extracted from Cobb's remains and weighed, the total is 0.0161 gram of arsenious oxide plus 0.0068 gram obtained from the alcoholic extracts. This sum was stated on the trial to be for all, except the last, as equal to a quarter of a grain. The amount *estimated* to be present in the latter was half a

grain, which we must correct as being on weighing subsequent to the trial 0.0068 gram, or $\frac{1}{10}$ grain. Making a very wide allowance in favor of the prisoner it was stated that, judging from the weighed and unweighed exhibits of arsenic in its various forms, we might consider the body to have contained at death one grain of white arsenic. If there was any error in the calculation, it was certainly one over which the counsel for the defense should make no complaint. We were perfectly aware of all the defects of reasoning that might be imputed, and sought the safe side.

Great as were the difficulties attending any computation of the quantity of residual poison in the body of Cobb, they were as nothing compared to those in the analysis of the viscera of Mrs. Bishop. Here only one weighing could be made, the arsenic as oxide amounting to 0.00064 gram, or $\frac{1}{100}$ grain. We say only one could be made, this is not strictly true, since a lesser amount than the six deci-milligrams might be ascertained by the balance; but with quantities so small the errors of weighing are so many that the process of analysis becomes unnecessarily lengthened. By a comparison of the arsenical mirrors, precipitates of sulphide, etc., in the Cobb and Bishop analyses, we sought for all essential information on the head of quantity. As we have repeatedly spoken of the relations found to exist in these two, we need not dwell on them more at length. The evidence of the *presence* of arsenic was, in the analysis of the remains of Mrs. Bishop, no less conclusive than that obtained from the body of Cobb, though from the latter a greater quantity was extracted.

With regard to the estimation by weight of the alkaloids, there is little information. Most chemists consider themselves fortunate in being able so to conduct an analysis as to obtain conclusive evidence of the vegetable poison, to say nothing of weighing the trace so extracted. The great difficulty lies in the complete separation of the alkaloid from other organic material, fatty and resinous substances.

We had no great trouble in ascertaining that the medicine prescribed for and taken by Cobb contained strychnine in definite weight, corresponding to that called for on the prescription. It was far different, however, in the separation of this same alkaloid from the tissues; yet strychnine presents a wonderful advantage over other alkaloids in that by treatment with strong sulphuric acid it is dissolved and capable of separation on the addition of water and an alkali, while other organic matters are destroyed, carbonized often by the strong acid. We are driven therefore to expedients in estimating the quantity far more gross than the approximate tests for the metals. Indeed the only course left open is at times that of exclusion, by employing in succession tests of known delicacy until one is at last reached, beyond which no signs of the poison are shown.

Thus we may say that though the bitter taste was wanting, the color reaction of strychnine was quite apparent.

We may sum up the whole matter in saying, as regards all quantitative testing, especially that which deals with any absorbed poison, that the chemist cannot be too guarded, both as to methods of research as well as to deductions.

Post-Mortem Imbibition. Diffusion of Poisons.—Though the question of post-mortem imbibition in Cobb's remains did not arise, for the suspicion of foul play existed before his death, and an autopsy was held at the earliest moment subsequent nevertheless, there are certain vital questions that of late have been the subject of debate among toxicologists that were held in mind during this analysis, and we now desire to direct attention to them.

The tissues of a dead body may become impregnated with poisonous substances from many causes, but we can divide them into two classes—the accidental and the intentional. Under the former heading we may note the absorption after burial, from the body lying either in contact with or being wetted with water carrying some foreign substance in solution; under the latter, either malicious introduction of a poison, or the injection of solutions for the purpose of embalming. Little need be said at the present day about the infiltration from the soil. Jurists have their pet theories for defense, and the fashion thereof changes from year to year almost as certainly as a dame's attire. For a long time, whenever the chemist detected poison, especially arsenic, in the remains of a deceased person after long burial, the claim was raised by the prisoner's counsel that the soil contained all the necessary material wherewith to saturate the body. Such arsenic has been known as "cemetery arsenic." Chemistry was able to cope with such an argument; it proved that the arsenic present in most ferruginous soils was not that form which is used to destroy life, but is so intimately combined with the earthy matter as to resist solution except by prolonged treatment with acids. Dragendorff (1) gives several hypothetical cases of contamination with arsenic, stating very clearly the exact precautions to be taken by the chemist, in order to completely and successfully obviate any errors that might arise from this source. Such an exceptional case as that cited by Frezenius (2) where, on the decay of the coffin, the arsenical ochre used as a paint on the wood became mingled with the dust of the remains and gave rise to the finding of arsenic, is a curiosity in toxicological literature.

The coffin, after burial, generally presents much of the appearance described in the record concerning Mrs. Bishop. Due precautions must be taken by the chemist to avoid any such circumstances as may invalidate his analysis.

(1) Op. cit, p. 328 Et. seq.
(2) Zeitschrift f. Anal. Chem. VI. 200.

The matter is far different, however, when we consider the other questions, viz., that of malicious introduction after death, or the attempts to arrest putrefaction by the injection of antiseptics. And here, we must assume two possible methods of introducing the poisonous substance—either its introduction in the abdomen, in bulk, or its injection through the circulatory system. Either of these may be employed, whether by the evil-minded or the embalmer. A subcutaneous injection without entering any large blood vessel, or the introduction of the poison through any of the apertures of the body, would be but a modification of the first method of procedure. The radical difference between the two means of imbibition is, that in the first the infiltration is necessarily slow, and depends entirely on the process of osmosis, while in the latter the poison is rapidly disseminated through the entire body, and the subsequent osmosis proportionately speedy.

The chemist must in some cases seek to disprove any introduction of poison in the remains analysed. Taylor (1) states: "It is true that a large quantity of poison may be injected into the stomach or rectum after death. Such a state of things would be indicated by the absence of symptoms and appearances. These contingencies tend to show how important it is that we rely not too strongly or implicitly on mere chemical results. The discovery of *absorbed* poison removes any difficulty in respect to injection after death, and proves that the poison must have entered the body during life, provided we have satisfied ourselves that there could have been no cadaveric imbibition from the soil." To demonstrate by analysis the presence of *absorbed* poison, he states, p. 152, it must be sought for "in the blood, in the liver, in the spleen and kidneys, in the heart, in the lungs, in the muscles." Further on the same page: "If the poison be detected as a deposit in the tissues of any of the organs, and due allowance be made for imbibition from adjacent viscera, there can be no doubt of its having been introduced into the body during life."

Dr. Reese, in the paper already referred to, after viewing the malicious introduction of poison after death as an improbable occurrence, scarcely credible, citing Orfila as believing human depravity to be almost incapable of such degradation, speaks of a case in a western city, of which he could only obtain the outline, where an accusation of poisoning was preferred, the presence of arsenic demonstrated in the chemical analysis of the remains, but the legal proceedings dropped on the ground of probable malicious tampering with the body by the accuser. He therefore deems it essential that the chemist should be fortified against any such possible fraud, and opens the way to a discussion of this important medico-legal topic. He goes a step further than Taylor; at his sug-

(1.) Op. cit. p. 160.

gestion experiments were made by Dr. McCracken, with a view to supplying data wanting in toxicological literature. From these experiments, as might naturally be anticipated, metallic solutions were found to diffuse through the various tissues, more or less rapidly according to the nature of the metal, and to a greater or lesser depth in such organs as the liver, proportionately to the time. Dr. Reese therefore argues that, by comparative analyses of the interior with the exterior of the same organ not long after death, he could decide whether the poison was *absorbed* or *imbibed*. Dr. Reese, in addition, then quotes the researches of M. Scolosuboff (1), wherein the latter claims that the brain and spinal cord become the seats of localization of arsenic in cases of poisoning. In detailing the results of the analyses both of Mr. Cobb and Mrs. Bishop (p. 35), we spoke of the amount of arsenic extracted from the brains of each, and of the comparative amounts in other organs, showing that although arsenic was detected in the nerve tissue, no such amount could be found as the results of Scolosuboff would indicate. For the present we must content ourselves with these results—to subsequent analyses must be left their corroboration. Dr. Reese very properly advises the expert to examine the brain as an essential point, and thus establish a criterion for cases of supposed imbibition.

To eliminate the question of post-mortem imbibition, we would make comparative analyses of solid organs, with separation of internal and external portions, or of parts contiguous and non-contiguous to any organ that on simple inspection shows indications of poison; we would analyse the muscular tissue and bone, as well as the brain —(a foot or a hand, for instance); and subject urine, fæces or bile, in default of any vomited matter, to analysis. We see especial reason for critical analyses of the liver and gall bladder with any bile it may contain, if, as in the case of Mrs. Bishop, a much larger proportionate amount of arsenic should be obtained from the hepatic *secretion* than from the hepatic *tissue*, we should have perhaps the most conclusive evidence of a truly *absorbed* poison.

In the second mode in which a foreign substance is disseminated through the human body after death, the injection of, say, an arsenical solution through the blood vessels, it would be for the chemist a task of exceeding difficulty to discriminate between poison so introduced and poison administered during life. Such a case would belong perhaps to that category wherein are placed all the most vexed questions of toxicology—such as the possibility of detecting various alkaloids, arrow poisons, the poisons of insect or snake bites, and a thousand other similar propositions; happily we rarely are called upon to draw such fine distinctions. We do not desire to beg a question of such importance, and frankly acknowledge a case as

(1.) Op. cit.

possible, in which from chemical data only the analyst would be unable to distinguish between the poison that killed and the same poison used to embalm the body.

When cremation of the dead was proposed, it was argued that it would in some cases destroy all evidence of murder either by violence, or by poison; as cremation has not become popular, we need not dwell upon this bearing of the subject. Embalming, however, is daily practised, and resorted to for a class of society in which, if foul deeds are perpetrated, there are both opportunities and means enough for keeping such matters secret. Is it not, under such circumstances, advisable to regulate by law—to license, in other words—those who are to perform such offices for the dead, and to enforce the employment of liquids free from such chemical substances as would interfere with any subsequent analysis? We need only direct attention to such bodies as carbolic and cresylic acids, thymol, sulphurous acid, salicylic acid, or even charcoal, among others, to show that there are abundant means at hand to accomplish a result now generally attained by the use of zinc or arsenical solutions. Is it not the province of the Medico-Legal Society to investigate such matters, and suggest the proper remedies?

In closing, we must add a word or two upon the amenabilities as well as the amenities of experts. Should the chemist be called upon to testify as to whether the poison detected on analysis caused death, other causes of death being excluded? We claim that he should not, since such a question requires the expression of a medical opinion, and the expression of an opinion upon a purely medical point may vitiate his testimony in the eyes of the jury. The all important problem for the chemist to solve, is whether or no poison is present; to the medical witnesses should be left the burden of proof as to whether the amount found indicated, in connection with symptoms and post-mortem appearances, the cause of death. No cross-examination should shake the chemical expert, the main fact should stand firm and comprehensible before the jury; but a skillful advocate may draw him into the toils and entrap him into unguarded expressions of opinion, whereby the elaborate research, and experimental proof will go for naught, the *facts* adduced by the chemist may be lost sight of, being buried under the mass of contradictory testimony that the defense hurls at him in the refutation of his *opinions*. Then, too, the toxicologist, though frequently more familiar with the properties of poisons, their dose, or their characteristic symptoms, as stated in the books than is the physician, yet he is by force obliged to relinquish the practice of medicine and devote his attention to the laboratory, he is therefore more or less unqualified to answer questions pertaining more strictly to medical topics. We deem it the chemist's duty to fully establish the data upon which the medical witnesses

may found a true opinion ; we believe a judicious counsel will refrain from detracting from the main feature in opening a discussion of side issues.

There is a notion, only too prevalent, that the chemist employed by the State is but an *expert* for the prosecution, though he unfortunately for some reasons, must needs be a sort of prosecuting officer, to what extent, however, it is difficult to say. Such is not only manifestly an error but an injustice. In conducting a toxicological investigation, the examiner is frequently in the dark as to cause of death, or suspicion of any particular poison ; he is not employed by the State "to find poison;" slowly as the systematic analysis progresses the mystery unravels, till at length the demonstration is complete ; it may be either for or against the prisoner. This result attained a new line of investigation must be entered upon, for collateral evidence is perhaps wanting ; thus, as in the Cobb case, both the bismuth powders, and also the strychnine tonic prescribed by the physician, underwent chemical testing. Then, too, the evidence so gathered must be protected against the possible lines of defense. Perfect candor and frankness may and must be expected from him by the defense. Acting on such a basis, the chemist expects to be met by a searching cross-examination, his methods closely scrutinized, and the accuracy of his results discussed, and if his work is complete to have its accuracy admitted. There has been much of late that has not savored of such style of cross-examination; too frequently the expert is made the subject of personal abuse, not only by the lawyer "to save his client," but by the *scientific (?)* witnesses called in rebuttal ; and the newspapers take the cue for the sensational headings, "War of Experts," and "Doctors Disagree." On the opening of the trial the counsel for the defense took occasion to move for a postponement, on the ground that they had made an unsuccessful attempt to procure chemical experts to assist them in the criticism of the testimony to be offered by the prosecution, but while some of the gentlemen approached were unable to act, yet they did not hesitate to assert that the conclusions drawn from the preliminary analysis of Cobb's remains were premature. The complete corroboration of the preliminary analysis by every step subsequently taken and the results obtained, shows conclusively that if any opinion were hasty, it was certainly that of experts who volunteered an exception, and not that given by those conducting the analysis. Although one or two of the daily journals made allusion to the cross-examination and the rebuttal testimony brought by the defense in the Cobb trial under the headings mentioned, we do not hesitate to deny that any such "war" existed, the expert finally obtained by the defense to protect the interests of the prisoner, suggested the cross-examination, and gave his evidence in

so courteous a manner that it was outdone only by his admission that the presence of the poison was demonstrated to his satisfaction, an admission as generous as it was just. That there were differences of opinion both as to methods and to tests was natural the main point, remained unmoved—the poison was proved to be present, and was shown to the jury.

The conduct of the scientific portion of a criminal trial on such principles is of incalculable value, not only to the professions of Law and Medicine, but to the community. It enforces respect for scientific pursuits; it seeks but the truth, and when that is found, does not attempt to detract from it; it strikes terror into the hearts of evil-doers, to see the certainty of the detection of crime.